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REPORT

Site Characterization and Interim Remedial Action Plan

Bishop Tube Site
Frazer, Pennsylvania

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September 1998

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1. Introduction

O'Brien & Gere Engineers Inc. (O'Brien & Gere) has prepared this *Site Characterization and Interim Remedial Action Plan Report* for the Bishop Tube Facility ("Site") located in Frazer, Chester County, Pennsylvania (Figure 1). The site is approximately 13.7 acres in size and employs 30 people. Currently, the facility is used in the production of stainless steel tubing for a variety of industrial uses and has been utilized for the manufacture of tubing and related products continuously since the 1950's.

Since 1981, environmental investigation activities have been conducted by BCM Engineers Inc., later Smith Environmental Technologies and BCM Engineers/ATC (collectively referred to as BCM/Smith herein). These investigations have been conducted voluntarily by Christiana Metals Corporation, owner of the property, with oversight by the Pennsylvania Department of Environmental Protection (PADEP, formerly the Department of Environmental Resources).

The environmental investigations conducted to date have revealed the presence of predominantly ground water impact by primarily chlorinated volatile organic compounds (VOCs). Past operations at the facility have been identified as the likely sources of the VOCs detected in ground water and to a more limited extent in soil and surface water as described herein.

In 1998, O'Brien & Gere was retained by Christiana Metals Corporation to complete environmental investigation work and identify appropriate remedial measures for the Site. Specifically, this *Site Characterization/Interim Remedial Action Plan Report* (SC/RAP) has been prepared by O'Brien & Gere based on a detailed review of the information supplied by Christiana Metals Corporation and BCM/Smith for investigations conducted at the Site since 1981. With the exception of field reconnaissance/site visits conducted by O'Brien & Gere for remedial action evaluation purposes and the recent July 1998 ground water level monitoring event, the environmental information utilized in this report was acquired by BCM/Smith including: field observations and data, drilling/well construction logs, sampling analytical data and site-specific hydrogeologic data.

1.1. Purpose of *Site Characterization/Interim Remedial Action Plan Report*

This SC/RAP Report has been prepared for the following purposes:

- Provide an updated site characterization based on previous investigations and collected data as the basis for remedial action evaluation, planning and implementation.

- Present the interim remedial action plan and schedule to expedite the design and implementation of a remedial system to mitigate the migration of VOCs in ground water from the Site.

- Provide the basis for comment and discussion with the PADEP with respect to the Site conditions and remedial action plan, including the potential future entrance of the Site into a remedial program in accordance with the Pennsylvania Land Recycling and Environmental Remediation Standards Act (Act 2).

1.2. Report organization

The remaining portions of the SCIRAP Report are organized into the following sections:

Section 2 - Site Description: describes the facility and Site setting, and presents a history of environmental issues/investigations since 1981.

Section 3 - Summary of Recent Investigations: presents an overview of the recently completed activities by BCM/Smith and associated methodology and results of these investigation activities. This section also summarizes O'Brien & Gere's activities completed to date.

Section 4 - Site Characterization: provides the site characterization including geologic data, hydrologic data and soil, ground water and surface water VOC data. This information comprises the conceptual site model for the Site in terms of the source and distribution of VOCs, hydrogeologic characteristics and the fate and transport of ground water constituents.

***Section 5 - Interim Remedial Action Approach*:** describes the goals and overview of the proposed interim remedial system for ground water (detailed in Section 6).

***Section 6 - Interim Remedial Action Implementation Plan*:** presents the conceptual design of the ground water source control/hydraulic containment and treatment system and the required permits and associated plans; presents the performance evaluation activities and reporting to be developed for the remedial action; and presents the anticipated Implementation Schedule.

***Section 7 - References*:** presents the specific reports and documents used for information purposes as part of this report.

2. Site description

2.1. Site setting

The Bishop Tube facility is located in Frazer, Chester County, Pennsylvania (Figure 1). The facility land is owned by Christiana Metals Corporation and the facility (building) is owned and operated by the Damascus - Bishop Tube Corporation. The facility and land (Site) comprise approximately 13.7 acres and consist of a single 3.2 acre plant building (comprised of several additions), paved parking and storage areas and limited grass coverage areas. A Site Plan is provided as Figure 2. The facility currently manufactures stainless steel tubes from flat steel rolls delivered to the Site.

Site topography slopes to the north/northeast with ground elevations ranging from approximately 500 ft mean sea level (M.S.L.) at the southern property boundary to 380 ft M.S.L. at the northern property boundary. A surface water stream, Little Valley Creek, borders the Site to the east, which runs south to north, before turning east in the valley approximately 1,000 ft from the Site. Across the stream to the east are residential dwellings. The remainder of the Site to the north and west is bordered by commercial property. Also, to the immediate north of the Site is a drainage swale on the Conrail railroad right-of-way. The southern perimeter is bordered by the Amtrak rail line near the ridge crest.

2.2. Site investigation history

Based on historical uses of the facility for metal working and tube manufacturing, environmental investigations conducted have appropriately focused on identifying impacts to soil, ground water or surface water as a result of these historical activities.

In 1981, BCM/Smith investigated potential impacts from closed waste impoundments on surface water and ground water at the facility. With the approval of the PADEP, four shallow monitoring wells (MW-1 through MW-4) were installed in the shallow overburden ground water zone at that time. Monitoring well MW-1 penetrated into weathered bedrock. The results of the study documented elevated fluoride levels in ground water for one well with respect to the drinking water standard.

In 1987, fluoride was detected in ground water that infiltrated into a sump within the plant. Due to an inadvertent connection between the sump and the plant's National Pollutant Discharge Elimination System (NPDES) permitted non-contact cooling water discharge, the discharge exceeded the permitted average monthly limit of 10 mg/l for fluoride. The sump water was then pumped by the facility to temporary storage for off-site transportation and treatment.

A work plan was developed in July 1987 by BCM/Smith to install additional monitoring wells, collect soil samples in the vicinity of the abandoned waste impoundments, and collect and analyze water samples from the monitoring wells and the adjacent stream. These activities were conducted to update the 1981 study and extend the effort to include other ground water constituents of concern, including the degreasing agents historically used at the plant. The PADEP reviewed and approved the work plan prior to implementation. The investigation included the installation and sampling of five additional ground water monitoring wells (MW-5, MW-6, MW-7, MW-8, and MW-9), soil sampling from five soil borings and the collection of three stream water samples. The results of this investigation indicated the presence of VOCs, primarily trichloroethene (TCE) and 1,1,1-trichloroethane (TCA), in ground water. Some metals were also detected in soil and ground water samples collected at this time. The results of this investigation were reported to the PADEP in the May 1988 *Ground Water Quality Investigation Report* (BCM/Smith).

A subsequent draft work plan was prepared by BCM/Smith and submitted to PADEP during a meeting between representatives of PADEP, BCM/Smith, and Christiana Metals Corporation on July 26, 1988. This additional work was designed to further delineate the extent of TCE and 1,1,1-TCA in ground water. During this meeting, PADEP requested that quarterly ground water monitoring be conducted in the vicinity of the east end of the plant where the cooling water discharged to the adjacent stream. This monitoring was requested to document levels of fluoride in ground water, which were expected to decrease with time as a result of improvements made in the pickle liquor handling practice. Prior to submission of a revised work plan to include quarterly monitoring, a soil vapor survey (SVS) was conducted (October 1988) along the north side of the facility. The results of the SVS indicated low concentrations of TCE, tetrachloroethene (PCE), and trans-1,2-dichloroethene (trans-1,2-DCE) in limited areas adjacent to the former outdoor TCE aboveground storage tank (AST), loading area, and concrete storage pad. A final *Ground Water Remediation Work Plan* (BCM/Smith, June 1989) was subsequently submitted to the PADEP for approval.

The 1989 *Ground Water Remediation Work Plan* proposed the installation of seven additional ground water monitoring wells (five shallow wells and two deep wells) numbered MW-10 through MW-16. Also proposed were five soil borings along the north side of the facility in areas identified during the SVS as containing low levels of VOCs. During implementation of the work, three additional soil borings were advanced adjacent to the degreaser tank located inside the plant. The monitoring well and soil boring locations are shown in Figure 2.

The results of this phase of the site investigation were presented to Christiana Metals Corporation in a report titled *Results of Implementation of Ground Water Remediation Work Plan, Phase I,* dated January 1990. This report characterized both ground water flow direction and water quality beneath the Site and directly downgradient. The investigation indicated that the indoor degreaser (former degreaser area) was the principal source of the VOCs detected in ground water with the outdoor former TCE AST being a potential secondary source.

Based on the analytical results of the soil borings drilled around the former degreaser area, an additional SVS was implemented during July 1990 along the transfer piping between the outdoor TCE tank and the former degreaser area. The results of the SVS along with the soil boring information further indicated that the former degreaser area was the primary source of TCE and related volatile constituents detected in surrounding ground water.

In November 1990, the *Scope of Work for Ground Water Investigation and Remediation* (BCM/Smith) was prepared and submitted to PADEP for review and approval. This *Scope of Work* defined tasks for vertical delineation of the VOCs present in the bedrock aquifer and collection of aquifer characteristic data necessary to plan a ground water remediation system. This document also summarized site environmental information to date for PADEP and included the results of the 1989 well search and SVS of the former degreaser area. In 1991, a report entitled *Summary of Quality Ground Water Monitoring Results* (BCM/Smith, December 1991) was submitted to the PADEP, which summarized the results of quarterly NPDES monitoring. In February 1992, a meeting was held with PADEP to review the 1990 *Scope of Work.* At this meeting, it was agreed that routine ground water monitoring conducted at the Site would be suspended until after the new monitoring wells were installed. The November 1990 *Scope of Work* was approved by PADEP in April 1992 and implementation of the field tasks was initiated in March 1995. A summary of the tasks completed as part of the 1990 *Scope of Work* and results are included in Section 3 of this report.

3. Summary of recent investigations

This section summarizes the more recent investigations conducted by BCM/Smith and the results as part of the 1990 *Scope of Work for Ground Water Investigation* and field reconnaissance activities conducted by O'Brien & Gere. Section 3.1 provides an overview and Section 3.2 provides details regarding these activities and results, generated from previous documents prepared by BCM/Smith, Section 3.3 provides the summary of O'Brien & Gere's recent activities. Section 3.4 discusses overall data quality for the recent ground water investigation results.

3.1. Ground water investigation (1990 Scope of Work) overview

The principal objectives of the 1990 ground water investigation were as follows: (1) investigate the on-site vertical extent of VOCs in the bedrock and perform aquifer performance testing for the design and installation of an on-site VOC source containment and remediation system; and (2) investigate the off-site vertical extent of VOCs in the bedrock ground water zone for the design and installation of a monitoring network that further delineates the off-site VOC plume geometry.

Field activities associated with the implementation of the 1990 *Scope of Work* were initiated on March 28, 1995, and included the installation of overburden, upper bedrock,[1] and lower bedrock monitoring wells. Two deep, lower bedrock wells (MW-17 and MW-19) and one upper bedrock well (MW-18) were installed. In addition, one overburden monitoring well (MW-20) was installed inside the plant adjacent to the former degreaser pit. The second overburden monitoring well proposed for installation off-site, on the east bank of the stream which runs along the east side of the plant,

[1]The upper bedrock zone is used in this report to generally refer to the upper 300 ft of the carbonate bedrock aquifer, based on the occurrence of water bearing zones/features regionally (81% within the upper 200 ft. reported by Sloto [1990] and beneath the site); 300 ft is also the shallowest casing depth of the deep bedrock wells.

was not installed because access could not be obtained. Table 1 provides a summary of the construction of the twenty Site monitoring wells.

The drilling of the deep, lower bedrock wells was conducted in an attempt to delineate the vertical extent of the VOCs in ground water, including field and laboratory analyses of ground water at specific intervals. During drilling of the on-site deep bedrock monitoring well MW-19, headspace analyses of the ground water removed from the borehole was performed with a portable gas chromatograph (GC). A portable organic vapor analyzer (OVA) was also utilized during drilling of the four new wells to provide a general assessment of ground water impact. Packer testing of specific water bearing intervals was performed during drilling of both lower bedrock wells (MW-17 and MW-19) and headspace analyses were performed with the on-site GC on ground water samples collected during pumping of the packered intervals. Several ground water samples collected from the packered test intervals were also submitted for laboratory analysis for TCE. In addition, downhole video camera logging and caliper logging were completed for the lower bedrock wells, and rock core samples were collected from MW-19.

Following the completion and development of the new monitoring wells, ground water samples were collected for laboratory analyses. Ground water samples were collected from the new monitoring wells, selected existing monitoring wells, and the one off-site domestic water supply well (b) (6) [redacted] shown in Figure 1) that was identified by BCM/Smith within a one mile radius of the site. Two surface water samples were also collected from the stream (Little Valley Creek) adjacent to the east side of the plant (designated Stream 1 and Stream 2, see Figure 2). In addition, one aqueous sample was collected from a discrete interval at the bottom of each of the two deep bedrock wells (total of two samples) with a Kemmerer® sampler for laboratory analysis for VOCs to assess the potential presence of dense non-aqueous phase liquid (DNAPL).

Approximately one week after completion of ground water and surface water sampling, an aquifer pumping test was performed. This test was preceded by an approximately 72-hour static water level monitoring program followed by a step drawdown test. Following the step drawdown test, an approximately 30-hour constant rate pumping test was performed using the on-site, deep bedrock well MW-19 (open interval of 300 to 422 ft. below grade at the time of testing) as the pumping well.

The descriptions of well drilling techniques, lithology, well construction, packer testing, GC analyses, aquifer testing and analytical data generated from these activities are presented in Section 3.2 below.

3.2. Methodology and results of ground water investigation

3.2.1. Installation of monitoring wells

Four of the five monitoring wells proposed in the 1990 *Scope of Work* were installed in 1995 (MW-17, MW-18, MW-19 and MW-20). These wells included two lower bedrock wells (MW-17 off-site and MW-19 on-site), one on-site upper bedrock monitoring well (MW-18), and one shallow overburden (unconsolidated) well (MW-20). The locations of the Site monitoring wells including the recently installed monitoring wells are shown in Figure 2. A summary of monitoring well construction details is provided in Table 1. Well logs of the Site monitoring wells are provided in Appendix A. The recently installed off-site deep, lower bedrock monitoring well, designated as MW-17, is located north of the railroad tracks and adjacent to previously installed wells MW-15 (upper bedrock) and MW-16 (overburden). The on-site deep, lower bedrock monitoring well designated MW-19, was installed along the north side of the plant building, adjacent to MW-2 (upper bedrock) and MW-3 (overburden) and downgradient of the former degreaser area. The upper bedrock well MW-18 is also located along the north side of the main plant building. The shallow overburden well MW-20 was installed adjacent to the former degreaser pit inside the building.

Steel casings were installed at various stages during the drilling of each of the deep, lower bedrock wells (MW-17 and MW-19) to reduce the potential for constituents to migrate downward due to drilling. Steel casings, extending to the ground surface, were installed in MW-19 to 90 feet below grade (bg), 200 feet bg, and 300 feet bg; and were installed in MW-17 to 84 feet bg and 204 feet bg.

During drilling of the borehole for MW-19, continuous rock coring was performed from 300 feet bg to 500 feet bg. Descriptions of the cored rock are provided on the well log for MW-19. The rock cores were also inspected by O'Brien & Gere. Rock cores are currently stored on-site and are available for viewing upon request.

3.2.2. Downhole video camera logging and caliper logging

Downhole video camera logs and caliper logs were run in both deep bedrock wells (MW-17 and MW-19) to aid in identifying potential water bearing features, formation lithology, orientation (dip) of features such as bedding planes, fractures and joints, and to aid in selecting packer testing intervals. For off-site well MW-17, video camera logs were run on the entire bedrock interval to a depth of 404 ft bg, with the exception of the upper 74 ft (10 to 84 ft bg). For the on-site deep bedrock well MW-19, video camera logs were run on the 90 to 300 ft bg bedrock interval; the upper 75 ft of rock (15 to 90 ft bg) was not logged. The lower 200 ft of MW-19 (300 to 500 ft bg) was also not video camera logged due to the small cored diameter of the well (3.88 inches) and because the rock cores obtained from this interval provided sufficient information. Caliper logs were run on the upper 148 feet of both deep wells and the logs are provided in Appendix B. VHS video tapes of the camera surveys were reviewed by O'Brien & Gere and are available for viewing upon request.

3.2.3. Packer testing

During the installation of MW-17 and MW-19, packer testing was performed on selected borehole intervals to evaluate the approximate yield of the formation and to assess VOC ground water concentrations within those intervals. For each packer test, an attempt was made to hydraulically isolate the borehole zone between the inflated packers and then pump from this isolated zone for hydraulic and VOC monitoring. Ground water pumped from the packered intervals was evaluated for VOCs by performing headspace analyses with a portable GC and limited laboratory analyses on select ground water samples. Eleven packer tests corresponding to individual packered intervals were performed on the two lower bedrock wells: four tests for MW-17 and seven tests for MW-19. In addition, one short duration aquifer pumping test was performed on the deep wells using the packer testing equipment. The hydraulic results, the results of volatile organic headspace readings measured with the GC, and the laboratory VOC analyses of select ground water samples collected from the packer intervals are provided in Appendix C.

The packer testing program generally consisted of assembling and lowering the packer assembly into the borehole to the test interval. Packer intervals were selected for both wells using the video camera logs, rock core samples, and the geologist's field logs of drilling observations. In general, packer testing intervals were evaluated by BCM/Smith on the following criteria:

- Visible secondary porosity features
- Smooth borehole sidewalls with no obvious fractures for placement of the packer seals
- Indications of permeability such as ground water flow into or out of the borehole.

A typical packer assembly included two inflatable packers, a pump, and three pressure transducers. The transducers were placed above, between, and below the two inflatable packers to independently measure the hydraulic pressure within the isolated interval and in the upper and lower bedrock zones. Upon lowering the packer assembly to the selected test zone, the packers were inflated with nitrogen and the pressure within each interval was monitored. After the pressure readings had stabilized, the relative hydraulic heads (in terms of ground water elevations) of the individual intervals were recorded.

A slug test was performed on the packed-off interval by pouring one gallon of deionized water into the lift pipe. The rate at which the slug (artificial positive head) dissipated into the formation was used to select the approximate initial pumping rate for each packer test and to assess whether a packer seal had been established. Further testing of zones that equilibrated from the hydraulic effects of the slug within 20 minutes was not performed. After the packed-off interval equilibrated from the slug test, the pump located between the packers was turned on to hydraulically stress the packered zone and water level changes were monitored with the three pressure transducers. The drawdown in the pressure head in the packed-off zone was recorded by a data logger until the pumping rate and formation yield had reached equilibrium or until a minimum of three volumes of water were removed from the packed-off interval.

During pumping, ground water samples were collected generally at the beginning, middle, and end of the test for headspace analysis by a field GC. Generally, recharge of the pumped interval was monitored until 90 percent of the total drawdown was recovered. When the recharge rate was low, recovery was monitored until a trend was established (approximately 20 to 30 minutes).

3.2.4. Field GC methodology

A field GC was utilized during drilling activities conducted in April 1995 which included the installation of MW-18 and MW-20 and the first 200 ft and 300 ft of MW-17 and MW-19, respectively. In addition, the field GC was utilized for the packer testing events in both deep, lower bedrock monitoring wells. The purpose for using the field GC was to analyze ground water headspace samples for the presence of TCE. Headspace analyses were performed to aid in assessing the vertical extent of TCE in ground water as encountered during deep well drilling activities. A Photovac portable GC, fitted with an isothermal capillary column and a photoionization detector (PID), was utilized for headspace analysis during drilling and packer testing activities. In general, headspace analyses were performed on samples of drilling fluid (ground water containing fine rock cuttings) during the April 1995 drilling activities and ground water samples collected at several time intervals during packer testing.

Twenty milliliters (ml) of drilling fluid and ground water were placed in a 40 ml bottle for the headspace sample, which were discarded after one use. The bottle lids were fitted with a Teflon coated silicon septa. Headspace samples were collected through the septa with a 250 microliter (μl) gas-tight glass syringe. Each sample was immediately injected into the GC for a qualitative analysis of volatile compounds detectable by a PID utilizing an ultraviolet lamp with a 10.6 electron volt potential. The analysis time was less than three minutes per sample using the isothermal capillary column maintained at 40° Centigrade. A quantitative analysis of TCE was also performed.

Field quality control (QC) procedures were also performed. A liquid headspace standard containing a known concentration of TCE was injected into the GC, at a minimum, at the beginning and end of a sampling event. This was done to aid in the quantification of TCE, if detected in the headspace samples, and to confirm that the GC was operating correctly. As part of these QC procedures, at least one column and/or syringe blank was also analyzed for every 10 headspace samples. The column blank consisted of analyzing the carrier gas running through the column of the GC to evaluate the potential for carry over of contaminants within the column from previous sampling locations (cross contamination). The syringe blank consisted of injecting a sample of ambient air into the GC using the same syringe used for collecting the vapor samples. The syringe blank was used to evaluate the potential for cross contamination within the syringe from previous sampling locations. If contaminants are detected in either blank, more blanks are analyzed until carry over contamination is no longer detected. No contaminants above background conditions were detected in any of the blanks.

The field QC headspace results from both packer testing events are summarized in Table 2. The evaluation of the packer test data is presented in Section 4, including an assessment of the TCE in ground water data with respect to the vertical delineation objective.

3.2.5. Ground water and surface water sampling

Ground water samples were collected in January 1996 from recently installed monitoring wells MW-17 through MW-20 and from existing monitoring wells MW-4, -9, -13, -14, -15, and -16. Several attempts were made to sample MW-1 (upgradient well) and MW-10, but neither well could be located by BCM/Smith due to burial during snow removal activities.

Ground water was purged from the wells equivalent to a minimum of three well volumes prior to sampling. Ground water samples were collected with dedicated, clear Teflon bailers on January 23-24, 1996 and on January 30, 1996.

Approximately three weeks prior to performing the ground water sampling activities discussed above, a discrete interval ground water sample was collected on January 4, 1996 from the bottom of the deep bedrock wells (MW-17 and MW-19) with a Kemmerer® sampler to assess the potential presence of a separate phase (DNAPL). In addition to the Site monitoring wells, a ground water sample was collected from the domestic potable water well located at [redacted] The location of this residence, relative to the Site, is shown in Figure 1. This untreated ground water sample was collected from the kitchen sink faucet. The kitchen sink is also fitted with a separate faucet from which treated water is drawn for drinking and cooking. In conjunction with the ground water sampling activities, two surface water samples (designated Stream 1 and Stream 2 locations) were collected from the stream located along the east side of the plant (Figure 1).

The 1996 ground water and surface water samples were analyzed for priority pollutant list (PPL) volatile organic compounds (VOCs) by EPA Method 601 (GC Method) and total and dissolved fluoride (EPA Method 340.2). In addition to these analyses, the surface water samples were also analyzed for total and dissolved chromium by EPA Method 6010. The discrete interval ground water samples collected from the bottom of the deep wells were analyzed for PPL VOCs only.

Table 3 presents a summary of the compounds detected in the ground water/private water and surface water samples collected in January 1996. The MW-17 and MW-19 bottom sample results are provided in Table 4. The analytical result data sheets for these samples and discrete interval ground water samples from the deep wells are provided in Appendix D.

The ground water and surface water sampling VOC results are discussed in Section 4.

3.2.6. Partial abandonment of MW-17/MW-19 boreholes

Following the completion of MW-17 and MW-19 and collection of bottom samples, but prior to the January 1996 ground water sampling event, portions of the MW-17 and MW-19 boreholes were grouted. This partial grouting of the open borehole was apparently conducted to reduce the potential for downward migration of DNAPL, if present, via the open borehole. On January 5, 1996, MW-17 was backfilled with grout from 404 ft to 300 ft bg, and MW-19 was backfilled with grout from 500 ft to 422 ft below grade.

3.2.7. Aquifer testing

Following the ground water and surface water sampling activities, an aquifer pumping test was performed in February 1996 to assess the bedrock aquifer using deep well MW-19 as the pumping well. The purpose of the aquifer test was to assess the sustained yield of this well, and the degree of hydraulic interconnection between the lower bedrock aquifer (MW-19 has an open interval of 300 to 422 ft bg) and the upper bedrock/overburden zones. Pressure transducers connected to data loggers were used on select overburden and bedrock wells to monitor changes in head throughout the duration of the aquifer test. During the constant rate pumping test, manual water level readings were also collected from the wells containing transducers as backup to the data loggers and also at additional wells.

Static water level measurements were collected at regular intervals for approximately 72 hours prior to the start of the aquifer pumping test. In addition, prior to conducting the constant rate pumping test, a step-drawdown test was conducted in MW-19 to aid in the selection of the pumping rate. Two pumping rates (3 gpm and 4.5 gpm) were tested for at least 100 minutes. During the step-drawdown test, drawdown in the pumping well (MW-19) and in the observation wells were recorded. This test indicated that the maximum yield of MW-19 was approximately 3.6 to 3.8 gpm with approximately 205 ft of drawdown (depth to water of 220 ft bg).

The constant rate pumping test, which began the day following the step-drawdown test, was run for approximately 30 hours. MW-19 was pumped at an initial rate of 10 gpm, which was lowered to 3.6 to 4 gpm due to an excessive rate of drawdown. Approximately 200 ft of drawdown was created due to pumping (specific capacity of approximately 0.02 gpm/ft). The pumping rate for the test and manual water level measurement, were recorded approximately every three hours throughout the test. Upon completion of the constant rate pumping test, the data loggers were reinitialized (set at the start of a log time sequence) and the pump was turned off. Ground water recovery data were recorded until the water level in the pumped well (MW-19) had recovered to a minimum of 90 percent of its original static level.

As part of the aquifer test, three ground water discharge samples from the pumped well, MW-19, were collected for laboratory analysis during the pumping portion. These samples were collected one hour after the start of the test, after 15 hours of pumping, and after 29 hours of pumping, just prior to stopping the test. These samples were analyzed for PPL VOCs (EPA Method 601) in unfiltered samples and for fluoride in both filtered and unfiltered samples (dissolved/total fluoride). In addition, the following selected ground water treatment design parameters were also analyzed:

- pH (measured in the field)
- total organic carbon (TOC)
- total suspended solids (TSS)
- total dissolved solids (TDS)
- total organic halogens (TOX)
- chemical oxygen demand (COD)
- alkalinity
- iron
- manganese

Results of the static water level monitoring, aquifer pumping test, and recovery data for the various wells included in the aquifer testing program are provided in a chart format in Appendix E. The VOC analytical results from the ground water samples collected during the pumping test are summarized in Table 5 and provided in Appendix D. These VOC results are discussed in Section 4.

3.3. O'Brien & Gere activities

The following activities were conducted by O'Brien & Gere in preparing this *Site Characterization/Interim Remedial Action Plan Report*:

- O'Brien & Gere reviewed the project files provided by BCM/Smith including previous reports, field notes, laboratory data, well search results, correspondence, field sampling logs, historical facility/site drawings, survey data and other relevant information. This review was conducted from March through July 1998.

- O'Brien & Gere obtained and reviewed an ERIIS database file report for the site and surrounding area, including a water supply well database and database of proximal sites with TCE/VOC ground water issues.

- O'Brien & Gere conducted Site walkover/inspections in March and July 1998 to observe site features, monitoring wells, two abandoned production wells, bedrock outcrops, and general Site setting. Pertinent data for utilities and placement of a potential on-site treatment system were also reviewed during these inspections.

- O'Brien & Gere collected synoptic ground water level measurements for Site monitoring wells and completed a detailed well integrity inspection on July 7, 1998. The ground water levels and resultant ground water elevations are presented in Table 1 and discussed in Section 4. The well inspection checklists are included in Appendix A; with the exception of monitoring well MW-10 which could not be located on July 7, 1998.

3.4. Data quality

O'Brien & Gere reviewed the available information and data for the site investigations conducted by BCM/Smith from 1981 through 1996. This information includes, as available: historic facility documents and drawings, field notes, sample field forms, raw analytical data packages/summary sheets, previous reports, soil boring and monitoring well logs and project correspondence. Based on this review and evaluation of this information, the qualitative and quantitative data generated are useable for the purpose of developing this *Site Characterization and Interim Remedial Action Plan*. Field procedures and sampling activities were consistent with applicable PADEP protocols and guidance. With the exception of the packer test ground water sampling data for TCE and possibly the ground water VOC concentrations for deep, lower bedrock monitoring wells MW-17 and MW-19, as discussed herein, the data are considered representative of environmental conditions in specific media and sample intervals. The TCE and other VOC ground water data for MW-17 and MW-19 are discussed in detail in Section 4.

4. Site characterization

This section presents the site characterization of soil, ground water and surface water based on the site investigations conducted to date and published hydrogeologic reports. Based on the environmental data generated to date, as documented in previous report submittals to the PADEP with the exception of the recently completed activities and data presented in Section 3, this site characterization section provides a concise summary of the hydrogeologic and contaminant conditions for the site. Specifically, this characterization focuses on the understanding of ground water flow conditions and the presence and distribution of VOCs in soil, ground water and surface water, and provides the basis for the expedited ground water remedial activities (interim remedial action) for the Site (Section 5 and 6). The site characterization presents conclusions regarding potential receptors and VOC migration based on available information.

4.1. Site geology

The Site is located within the Chester Valley of the Piedmont physiographic province in southeastern Pennsylvania. The northeast-southwest trending Chester Valley is underlain by carbonate rock units and is bounded by valley walls consisting of more erosion resistant noncarbonate rock units to the north and south.

The Site is located near the south valley wall identified as the South Valley Hills on the Topographic Quadrangle map for Malvern, Pennsylvania (USGS, portions provided in Figure 1). Based on the Preliminary Geologic Quadrangle for Malvern, Pennsylvania (Berg and Dodge, 1981) and on Sloto (1990), the developed northern portion of the Site property is underlain by the Cambrian - Ordovician aged Conestoga Formation, which generally consists of grey fine to coarse limestone to dolomite. The Conestoga Formation is overlain to the south by the older Precambrian - Cambrian aged Octoraro Phyllite (equivalent to the albite-chlorite facies of the Wissahickon Formation) which consists of green to silver grey phyllite (Sloto, 1990). The east-west trending boundary between the Conestoga

Formation and the Octoraro Phyllite is mapped (Berg and Dodge, 1981) in the vicinity of the southern limit of the developed Site area and is identified as a major thrust fault by Sloto (1990).

During field reconnaissance, O'Brien & Gere geologists measured planar orientations within rock outcrops in the vicinity of the Site. The primary foliation plane within an outcrop of the Octoraro Phyllite south of the Site along the Amtrack railroad cut was oriented with a N67°E strike and an 86°SE dip. The bedding plane within an outcrop of a carbonate unit, the Cambrian aged Ledger Dolomite (stratigraphically below the Conestoga Formation), located northwest of the Site on the south side of Conestoga Road between Conrail railroad tracks and Mill Lane, was oriented with a N69°E strike and a 68°SE dip. O'Brien & Gere inspected the rock core from the MW-19 boring and observed a very steeply dipping bedding plane orientation of approximately 75° to 85°. Given these field measurements, rock core observations and in consideration of the USGS mapped stratigraphic relationships and a geologic cross section presented in the Geologic Map of Pennsylvania (Pennsylvania Geological Survey, 1980), the Conestoga Formation beneath the Site is upright and dips steeply to the southeast as part of a fault bounded folded thrust slice of carbonate units within the Chester Valley.

The topography in the vicinity of the Site, located near the northern toe of the South Valley Hills, slopes northward toward the Chester Valley and locally eastward toward the Little Valley Creek. The Little Valley Creek, which originates in the South Valley Hills, flows northward along the eastern Site boundary then eastward through the Chester Valley, then flows into the Valley Creek, a tributary to the Schuylkill River. The depths to ground water in Site monitoring wells ranged between 0.3 and 18.4 feet below ground surface as measured on July 7, 1998 by O'Brien & Gere. Based on the O'Brien & Gere ground water level measurements for the Site and on a ground water elevation map by Sloto (1990) for the Valley Creek Basin, the ground water flow direction beneath the Site follows topography, generally flowing northward with an eastward component toward the Little Valley Creek. Sloto (1990) describes most ground water flow in the Valley Creek Basin as local with discharge to nearby streams, which is consistent with the eastward component toward the Little Valley Creek.

Depth to bedrock beneath the Site generally increases toward the east and Little Valley Creek, and varies from near grade to 26 feet below grade, based on information recorded on well logs across the Site. Overburden above bedrock was described as highly weathered colluvium which had migrated down slope from the Wissahickon Formation (Octoraro Phyllite Member) which occurs on the south of the Site (BCM/Smith, January, 1990)

Ground water beneath the Site occurs both in the overburden and in the bedrock. Ground water within the Conestoga Formation beneath the Site occurs primarily in secondary porosity generated by fractures. O'Brien & Gere observed nearly horizontal (subhorizontal) and bedding parallel (subvertical) fractures in the rock core from MW-19. Many of the subhorizontal fractures appeared to be enlarged by dissolution. It was difficult to assess the degree of opening within the bedding parallel (subvertical) fractures which occur along mica schist laminations. The steeply dipping bedding parallel fractures are interpreted to provide subvertical and along strike flow components. The rock core interval (296' - 500') for MW-19 only penetrates approximately 14 feet of stratigraphic thickness based on an assumed dip of 86°. The rock core, therefore, may not be representative of full aquifer conditions given the possible variation in lithology across stratigraphy and the resultant variation in fracture behavior (orientation, spacing, degree of opening). However, televideo logs reviewed for MW-17 and MW-19 also identified several subhorizontal fractures. Sloto (1990) reported that 50% of water bearing zones are encountered within 100 feet and 81% are encountered within 200 feet below land surface for 119 wells in Chester County in multiple carbonate units including the Conestoga Formation.

4.2. Ground water flow

A complete, synoptic round of ground water levels was completed on July 7, 1998 by O'Brien &Gere for the calculation of ground water elevations and assessment of ground water flow in the shallow overburden aquifer and the bedrock aquifer beneath the site. The water level data and resultant ground water flow elevations are presented in Table 1. Based on these data, the ground water potentiometric contour maps and flow maps for the overburden and upper bedrock aquifers are presented in Figures 3 and 4, respectively.

As shown, ground water flow is primarily to the northeast from the site in both the overburden and upper bedrock aquifer. In addition, there appears to be a eastward component of ground water flow on the east side of the plant towards the Little Valley Creek which is more pronounced in the overburden aquifer. Based on a comparison of ground water elevations and the surveyed stream elevations, ground water appears to discharge to this stream; although it is not known if the both overburden and bedrock ground water discharge to the stream. Based on the ground water elevations in nested well pairs, there is generally a slight downward hydraulic gradient which may be influenced by the steeply dipping limestone beds as discussed above. However, at the off-site nested well cluster MW-15, MW-16 and MW-17, there appears to be an upward hydraulic gradient from the upper bedrock monitoring well MW-15 to the overburden well MW-16. This apparent upward hydraulic gradient may be reflective of a seasonal variation in the ground water potentials. It is also noted in this off-site nested well cluster that there is a downward hydraulic gradient between the upper bedrock monitoring well MW-15 and the lower bedrock monitoring well MW-17.

The ground water elevations and flow directions were further evaluated using ground water potentiometric contour cross sections. Figure 5 shows the line of section for three cross sections presented in Figures 6, 7 and 8. Section A-A' (Figure 6) is along the apparent primary VOC plume migration direction (discussed in Section 4.3 below). Sections A-A', B-B' and C-C' present cross sections for varying directions with respect to formation strike and dip. On each cross section, an approximate apparent bedrock bedding plane dip angle is presented for illustrative purposes (the apparent dip has not been quantified) for the evaluation of geologic structure on the ground water flow direction; the bedding planes depicted in these cross-sections do not reflect actual bed thicknesses. As indicate in the cross sections, the direction of the ground water potential gradient in the overburden and shallow upper bedrock is primarily horizontal with a potential vertically upward component in the vicinity of the off-site nested well clusters. It should be noted that the cross sections are generated with a vertical exaggeration of 5 or 10 ft vertical to 1 ft horizontal, which has the effect of emphasizing the vertical gradient. Several ground water flow aspects are noted based on the areal and cross potentiometric maps as follows:

- As depicted in the ground water flow maps and vertical cross sections, there is a ground water flow component from monitoring wells MW-2/MW-3 and former degreaser area towards the majority of downgradient monitoring wells, including a slight downward component to the ground water gradient. As noted above, this area is the primary source area for VOCs in ground water based on site characterization data.

- As illustrated in the hydrogeologic cross-sections, the ground water potentiometric gradient is parallel to the direction of the bedrock surface slope. This indicates that in the three-dimensional flow model, ground water flow generally follows the overburden/bedrock interface.

- The Little Valley Creek adjacent and downgradient of the Site appears to be a gaining stream (i.e., ground water discharges to the stream), particularly with respect to the overburden ground water elevations and flow direction, based on the July 7, 1998 monitoring data. The bedrock component of flow to the stream, if any, is not evident by the ground water elevations, but the apparent upward ground water potentiometric gradient in the off-site well cluster (MW-15 and MW-16) and work by Sloto (1990) suggest that there could be an increase in the bedrock flow component to the stream further downgradient in the valley.

4.3. Nature of VOC Contamination

4.3.1. Ground water - monitoring well samples

The primary ground water constituents of concern are chlorinated VOCs, predominantly tetrachloroethene (PCE), trichloroethene (TCE) and 1,1,1-trichloroethane (TCA), plus common degradation products including 1,1-dichloroethane (DCA), 1,1-dichloroethene(DCE) and trans-1,2-DCE (trans-1,2-DCE has been detected; to date, ground water samples have not been analyzed for the common degradation product cis-1,2-DCE). Vinyl chloride has been detected in ground water samples from monitoring wells adjacent to the plant, however vinyl chloride has not been detected in off-site ground water samples (or surface water samples).

The complete historical VOC analytical data for ground water are presented in Table 6. Table 6 includes the data generated from monitoring well ground water sampling since 1987, including VOC data from NPDES monitoring events and recent sampling. This table does not include the laboratory analytical results from packer testing (TCE analyses only), bottom samples from MW-17 and MW-19, or MW-19 1 hour/15 hour pump test analyses which are discussed in Section 4.3.3. below. (Table 6 does include the results for the ground water sample collected after 29 hours of pumping MW-19).

As shown in Table 6, TCE and 1,1,1-TCA are the VOCs that have been historically detected at the highest concentrations in ground water samples. Based on the most recent sampling event for the monitoring wells, the following VOCs were detected in ground water, for the indicated number of wells, at concentrations exceeding the Act 2 Statewide Health Standards (Used Aquifer):

- PCE - 4 wells
- TCE - 19 wells
- trans-1,2-DCE - 2 wells
- 1,1-DCE - 4 wells
- Vinyl chloride - 1 well
- 1,1,1-TCA - 13 wells
- 1,2-dichloropropane - 3 wells

As indicated above, TCE is the most prevalent compound detected in ground water. As discussed below, TCE is also present at ground water concentrations at large percentages (> 10%) of its aqueous solubility limit from literature (1,100 parts per million (ppm), Cohen, 1993). These TCE concentrations, as well as high concentrations of other VOCs relative to aqueous solubility limits, typically indicate the presence of DNAPL.

To further assess the distribution and migration of VOCs from the site, the TCE ground water concentrations were evaluated based on areal maps and vertical cross sections as described below.

4.3.2. Distribution of TCE in ground water

As discussed in Section 4.3.1, the distribution of TCE concentrations is considered to be representative of the overall VOC distribution in ground water at the site for the purpose of this evaluation. Therefore, the horizontal and vertical distribution of TCE concentrations in the overburden and upper bedrock ground water zones were used to illustrate the distribution of impacted ground water at the site and are shown in Figures 9 to 13. The lower bedrock ground water zone, represented by monitoring wells MW-17 and MW-19, was not utilized for this evaluation based on the potential for vertical cross-contamination during the installation of these wells (described in Section 4.3.3. below) and the number of lower bedrock ground water sampling points. Based on the available ground water quality data for the overburden and upper bedrock monitoring wells, the most comprehensive sampling of ground water from Site monitoring wells occurred from August 1989 to July 1990, with the exception of wells MW-18 and MW-20 which were only sampled in 1996.

To illustrate the distribution of TCE concentrations, the average TCE concentrations detected in ground water from monitoring wells MW-1 through MW-16 were calculated using the 1989 to 1990 data. For monitoring wells MW-18 and MW-20, the TCE concentrations from the 1996 ground water sampling event were used.

Figures 9 and 10 illustrate horizontal distribution of TCE concentrations in the overburden and upper bedrock ground water zones, respectively. Figure 9 indicates that the highest TCE concentrations detected in the overburden ground water coincide with the area in the vicinity of MW-3 (former TCE AST area) and the former degreaser area. The TCE ground water concentration detected at MW-8, located downgradient of a former impoundment area, is also elevated with respect to surrounding ground water samples. These results suggest that the higher TCE concentrations may be the result of more than one historical source of TCE or that the TCE from the vicinity of MW-3 may have migrated along the bedrock surface. The high TCE concentrations (> 10 ppm) in the overburden ground water near monitoring well MW-3 appear to have migrated in a northeast direction. This apparent migration direction is consistent with the general overburden ground water flow direction (Figure 3), as shown in gray scale in Figure 9.

Figure 10 indicates that the TCE concentrations detected in the upper bedrock ground water zone are consistent with the overburden TCE distribution, with the highest TCE concentrations at the MW-2 and MW-9 locations. MW-2 and MW-9 are the upper bedrock monitoring wells nested with overburden monitoring wells MW-3 and MW-8, respectively. The TCE concentrations (>10 ppm) in the upper bedrock ground water near monitoring well MW-2 appear to be migrating in a northeast direction toward monitoring well MW-15, which is similar to the overburden TCE isoconcentration map (Figure 9). A comparison of Figures 9 and 10 indicates that the configuration of the TCE isoconcentration contours in the upper bedrock zone is oriented more to the east than the overburden TCE orientation and more along the approximate formation strike direction (approximately N67-69°E). As expected, this suggests that the ground water flow and VOC migration in the upper bedrock zone is affected by the geologic structure.

To further evaluate the distribution of TCE concentrations, the TCE concentrations detected in the ground water from the overburden and upper bedrock monitoring wells were contoured on the same cross-sections in Figures 11, 12, and 13, which represent cross-section lines A-A', B-B', and C-C', respectively. A review of the Figure 11 (A-A' section line) indicates that the highest TCE concentrations (>100 ppm) are generally limited to the overburden ground water zone in the vicinity of monitoring well MW-3 and that elevated TCE concentrations (>10 ppm) in the upper bedrock ground water zone have apparently migrated downgradient to the vicinity of monitoring well MW-15. This apparent migration direction of the elevated TCE concentrations was also noted in the upper bedrock TCE isoconcentration contour map (Figure 10). Figure 12 (B-B' section line) also indicates that the highest TCE concentrations (>100 ppm) are limited to the overburden ground water zone in the vicinity of monitoring well MW-3. A further review of Figure 12 (B-B' section line) indicates that the TCE concentrations (>10 ppm) detected in the ground water in the vicinity of monitoring wells MW-2 and MW-11 appear to be separate from the similar TCE concentrations (>10 ppm) detected in ground water in the vicinity of monitoring wells MW-8 and MW-9, which suggests that there may have been more than one source of TCE at the site.

4.3.3. Evaluation of TCE in lower bedrock monitoring wells

As detailed in Section 3 above, the two lower bedrock monitoring wells, on-site well MW-19 and off-site well MW-17 (Figure 2), were drilled and packer tested in an attempt to define the vertical extent of TCE impacted ground water. The drilling and testing methodology consisted of air rotary drilling generally in 50 ft vertical increments followed by air development of the drilled zones. Drilling fluid samples were tested with an on-site GC for the presence of TCE and other VOCs. A limited number of drilling fluid/ground water samples were also submitted for laboratory analysis for TCE. In addition, packer testing was conducted in 50 ft or 100 ft increments which included pumping the packer zone and inducing drawdown in each interval. The sequence of drilling and packer testing was continued in the open boreholes with no apparent decline in the TCE drilling fluid/ground water concentrations. Periodically, drilling was also interrupted to allow the open bedrock intervals to be televideo logged. The drilling activities were conducted from March through December 1995.

Subsequent to well completion, bottom aqueous samples were collected from MW-17 and MW-19 to assess the potential presence of DNAPL, and ground water samples were collected from the lower bedrock wells in January 1996. A portion of these boreholes were grouted in January 1996, prior to ground water sampling.

O'Brien & Gere completed a detailed review of the lower bedrock well drilling logs, well construction, recorded televideo logs, field GC data, packer test hydraulic/VOC data, and bottom water sampling and ground water sampling results. This review was conducted to evaluate if the ground water TCE concentrations identified from ground water samples collected are representative of the vertical intervals and the open well intervals tested, or if deeper TCE/VOC ground water concentrations for these samples resulted from drilling activities and the packer testing hydraulic stresses through areas of higher VOC concentrations and/or DNAPL. For this evaluation, the sequence of drilling and packer testing activities for MW-17 and MW-19 and associated TCE concentrations were evaluated. This evaluation is discussed for MW-17 and MW-19 below.

4.3.3.1. MW-17 information

MW-17 was drilled off-site adjacent to well MW-16 (overburden) and well MW-15 (upper bedrock) from March to December 1995. As shown in Table 6, the TCE ground water concentrations for the upper bedrock zone (MW-15) prior to drilling (1989 data) were 44 to 116 ppm (equivalent to approximately 4% to 10% of the TCE aqueous solubility suggestive of DNAPL). For comparison to MW-17, MW-15 has a screened interval of 68 to 78 ft below grade (bg). An initial steel casing (12" diameter) was set to 13 ft bg and the borehole was drilled to 84 ft bg. A flow rate of 20-30 gpm was estimated in this zone. No drilling fluid sampling was conducted and a second steel casing (8" diameter) was installed to 84 ft bg. The borehole was advanced to 150 ft bg, during which an opening was encountered at 108.5 ft bg with an estimated yield of 30 gpm. The borehole was developed and grouting of the 8" diameter casing was completed at this time, and the first packer test was conducted. The borehole was then advanced to 200 ft bg and developed and a second packer test was conducted. Water was noted to be flowing from the well after drilling to 200 ft, however, no significant yields were observed from the 150 to 200 ft interval. The borehole was advanced to 203 ft bg. Inflatable packers were placed to isolate the 108.5 ft zone which remained until November 1995.

In November 1995, a third steel casing (6" diameter) was installed to 204 ft bg. The hole was subsequently drilled to 404 ft bg (December 1995) in 50 ft increments with development and the conduct of 2 packer tests. The borehole, open from 204 to 404 ft bg, was estimated to have a total yield of 3 - 4 gpm with no significant water bearing zones/features noted.

Table 7 provides a summary of the MW-17 TCE results from grab samples analyzed by the field GC and laboratory. The open well intervals at the time of each packer test are also included in Table 7. Table 7 also includes the January 1996 bottom sample and ground water sampling TCE results. No TCE analyses were conducted for ground water/drilling fluid in the upper 84 ft bg, equivalent to the depth of the nearby upper bedrock well MW-15. The most recent TCE ground water data from MW-15 indicated a TCE concentration of 116 ppm. The first laboratory analysis of ground water/drilling fluids for the MW-17 borehole was collected in December 1995 during the 343-404 ft bg packer test, when the borehole was open from 204 to 404 bg; the TCE ground water concentration detected was 300 ppm (21% of the TCE literature aqueous solubility). This test was conducted after the borehole remained open to 200 ft from April - December 1995 and after inducing 350 ft of drawdown in the steeply dipping bedrock zone. The bottom sample exhibited a similar TCE concentration of 350 ppm, collected after the borehole was undisturbed for approximately one month. The ground water sample (January 23, 1996) collected after partial grouting contained TCE at 110 ppm. It is noted that this TCE concentration in the January 1996 ground water sample is equivalent to the upper bedrock concentration (MW-15) prior to drilling (1989 data) and that the January 1996 TCE concentration for the MW-15 ground water sample after drilling and packer testing MW-17 was 1.4 ppm, significantly less than the previous concentrations and suggesting a possible impact to the MW-15 ground water TCE concentration due to MW-17 installation activities.

4.3.3.2. MW-19 information

MW-19 was drilled on-site adjacent to well MW-3 (overburden) and well MW-2 (upper bedrock) and within the suspected TCE source area from March to December 1995. As shown in Table 6, the TCE ground water concentration for the upper bedrock zone (MW-2) prior to MW-19 drilling (1989 data) was 36.1 to 48.9 ppm, the TCE ground water concentration for the overburden zone (MW-3) was 199 to 680 ppm (equivalent to 18% to 62% of the TCE aqueous solubility). For comparison to MW-19, MW-2 has a screen interval to 24 ft bg.

For MW-19, an initial steel casing (10" diameter) was set to 18 ft bg and the borehole was drilled to 90 ft bg. A flow rate of 20-30 gpm was estimated from an opening at 44 ft bg. According to the drilling log, a yield of 85 to 95 gpm was estimated for the borehole to 90 ft bg. No drilling fluid sampling was conducted and a second steel casing (6" diameter) was installed to 90 ft bg. Difficulty in setting the casing was encountered, reportedly due to grout entering the opening at 44 ft bg, and it took 4 days to grout the 6" diameter casing. The borehole was advanced to 150 ft bg, and developed with an approximate yield of 2 - 3 gpm for the 90 to 150 ft bg zone. The first packer test was conducted. The borehole was then advanced to 200 ft bg and a second packer test was conducted. No significant water bearing zones were noted from 90 to 200 ft bg and the borehole yield was estimated at 2 - 3 gpm. The borehole was advanced to 300 ft bg with a significant estimated yield increase to 100 to 200 gpm, predominantly due to horizontal fractures (televideo log) at 260 to 268 ft bg and 279 ft bg. The third packer test was conducted (at a flow rate of 25 gpm). The borehole remained open from 90 to 300 ft bg until November 1995.

In November 1995, a third steel casing (4" diameter) was installed to 300 ft bg. Bedrock coring was begun and the hole was cored to 406 ft bg with development and the conduct of one packer test. The borehole, open from 300 to 406 ft bg, was estimated to have a total yield of less than 5 gpm with no significant water bearing zones/fractures. The borehole was cored to 500 ft bg with no appreciable increase in yield and developed by pumping. A packer test was conducted (a second packer test was attempted from 420 to 500 ft bg but was abandoned due to the absence of identifiable flow).

Table 8 provides a summary of the MW-19 TCE results from packer test grab samples analyzed by the field GC and laboratory. The open well intervals at the time of each packer test are also included in Table 8. Table 8 also includes the January 1996 bottom sample, ground water sampling and MW-19 pump test TCE results. No TCE analyses were conducted for ground water/drilling fluid in the upper 90 ft bg, which overlaps with the depth of the nearby overburden well MW-3 and upper bedrock well MW-2. The most recent TCE ground water data from MW-3 and MW-2 indicated TCE concentrations of 680 ppm and 48.9 ppm, respectively. The first laboratory analysis of ground water/drilling fluids for the borehole was collected during the 165-200 ft bg packer test, when the borehole was open from 90 to 200 bg; the TCE ground water concentration detected was 250 ppm (18% of the TCE aqueous solubility). It is noted in Table 8 that for several of the packer tests in MW-19, drawdown was measured in the borehole interval above the packered interval, indicating that the packered zones were not hydraulically isolated from the upper borehole and bedrock zone. The bottom sample exhibited a similar TCE concentration of 380 ppm, collected after the borehole was undisturbed for approximately one month. The ground water sample (January 23, 1996) collected after partial grouting contained TCE at 510 ppm. It is noted that this TCE concentration is within the range of TCE concentrations for MW-2 and MW-3 prior to drilling; no post-drilling MW-2/MW-3 ground water samples have been collected to date.

The February 1996 pump test TCE results from MW-19 (Table 8) detected TCE in ground water at levels which declined with pumping from 1,200 ppm to 660 ppm. These ground water samples were collected after the borehole was undisturbed for 3 weeks and collected through a pump set at 330 ft bg.

4.3.3.3. Summary of lower bedrock TCE concentrations

Based on the information presented above for MW-17 and MW-19, the geologic setting for the Site and the general behavior of TCE in ground water, the following conclusions are made:

- Based on the generally higher TCE concentrations and their magnitude detected from packer test intervals from the bottom of the borehole and aqueous bottom samples, DNAPL likely accumulated within each boring.

- Given the absence of appreciable yields in the lower 200 ft (MW-17) to 300 ft (MW-19) of the boreholes, the presence of the relatively high TCE concentrations is likely due to the influence of drilling, development and packer testing activities in combination with upper bedrock/overburden residual TCE levels and the steeply dipping bedrock formation. It is also possible in the MW-19 and MW-2/MW-3 source area that some downward migration of DNAPL has occurred along bedding planes. Although significant yields were not encountered at greater depths (greater than 300 ft bg), DNAPL may be present in low permeability openings in the bedrock. The effect of drilling and testing of MW-19 may have mobilized this DNAPL into the borehole, resulting in high TCE concentrations in MW-19 ground water samples collected from greater depths which are not representative of ground water quality in this zone. Further, based on the significant TCE concentrations in ground water samples from MW-2 and MW-3, the TCE concentrations present in the MW-19 borehole were most likely elevated due to drilling and testing activities.

- Given the steeply dipping beds, identified Site source area, and the potential for DNAPL/TCE migration along the bedrock/overburden interface (see Section 4.3.1 above), the detected deeper (greater than 200 ft bg) TCE concentrations for MW-17 may also be attributed to drilling and testing activities. This is also supported by the appreciable yields (30 - 60 gpm) within the upper 108 ft of the MW-17 borehole, the absence of identified horizontal fractures and water bearing zones beneath 200 ft bg, and the previously detected upper bedrock TCE ground water concentrations for MW-15.

- For both MW-17 and MW-19, significant ground water yielding zones were cased off in the upper 100 ft boreholes and ground water was not sampled from these zones. In addition, a significant water bearing zone from 260 to 280 ft bg was cased off in MW-19. These prolific zones are of concern with respect to TCE impact, particularly with respect to potential cross-contamination from shallow overburden and upper bedrock TCE concentrations.

- The information indicates that TCE in ground water and potential DNAPL may be mobilized with pumping due to the hydraulic stresses created in the bedrock aquifer, and suggests that hydraulic containment for source control and VOC removal be implemented by containing the shallower overburden/upper bedrock zones with greater hydraulic yields.

4.3.4. Domestic water supply well sample

As discussed in Section 3 above, a water sample was collected from a downgradient private water supply well (Figure 1). Based on the well search results and BCM/Smith correspondence notes, this well is approximately 225 feet deep with 20 ft of casing. This corresponds to an approximate open interval of 20 to 225 feet below grade (approximately 305 to 100 ft M.S.L. in elevation). The water sample was collected from the untreated water line which is not used for drinking or cooking at the residence. The water sampled exhibited TCE at a concentration of 0.053 ppm, 1,1,1-TCA at a concentration of 0.0081 ppm, and 1,1-DCA at a concentration of 0.0011 ppm. This TCE concentration exceeds the Primary Drinking Water Standard (Maximum Contaminant Level) and Act 2 Statewide Health Standard (Used Aquifer) of 0.005 ppm; however, this ground water supply is currently treated by the resident to remove TCE, 1,1,1-TCA, 1,1-DCA and similar VOCs which could potentially be present prior to drinking water use. Therefore this potential exposure pathway is considered incomplete based on the ongoing treatment system to remove VOCs.

4.3.5. Surface water

Grab surface water samples were collected from the Little Valley Creek adjacent to the Site at locations (Stream 1 and Stream 2) depicted in Figure 2 and were laboratory analyzed for VOCs and total/dissolved fluoride in January 1996. The analytical results (Table 3) indicated the presence of TCE in surface water at sample locations Stream 1 and Stream 2 (Figure 2) at concentrations of 0.075 and 0.010 ppm, respectively. These concentrations exceed the Surface Water Quality, Human Health standard for TCE of 0.003 ppm, but are less than the Fish/Aquatic Life standard of 0.45 ppm (PA Code Title 25, Chapter 16). In addition, 1,1,1-TCA was detected in the Stream-1 sample at a concentration of 0.019 ppm, which met Surface Water Quality Standards (Human and Fish and Aquatic Life) for 1,1,1-TCA. No other VOCs were detected in the stream samples.

Based on the ground water and surface water elevations, the hydrogeologic cross sections presented above, and the detected TCE concentrations in the surface water samples, it appears that the stream quality has been impacted by TCE and 1,1,1-TCA from the Site ground water. The data suggest that the overburden zone may be the primary ground water zone contributing base flow to the stream from the Site. The confirmation and mitigation of this potential discharge of VOC impacted ground water will be a component of the expedited interim remedial program as discussed in Section 6.

4.3.6. Soil

Due to the detection of VOCs in ground water and soil vapor samples, and to a lesser degree metals and fluoride in ground water, a focused soil boring and sampling program was conducted at the Site, primarily for VOCs in soil in the vicinity of the former degreaser area, the former TCE AST area/north plant area outside the plant, and two former impoundments areas to the east and south of the plant. Soil boring locations are shown in Figure 2. Soil samples were collected in 1987 from six borings in areas south (four borings) and east (two borings) of the facility building in the vicinity of the former impoundments. The soil samples were submitted for laboratory analysis of VOCs (purgeable halogenated compounds by USEPA Method 601) and total chromium, nickel, copper, zinc, fluoride and nitrate/nitrogen. In 1989, soil samples were collected from 7 borings north of the facility building in the vicinity of the former TCE AST and three borings inside the plant adjacent to the former degreaser area. These soil samples were analyzed for VOCs (USEPA Method 8010).

The results of the soil sampling are summarized in Table 9 by Site area, number of samples, detected compounds and maximum concentrations which exceeded current Act 2 Statewide Health Standards for soil (nonresidential). As shown in Table 9, five VOCs were detected in one or more soil samples from borings proximal to the former degreaser/north plant area, at concentrations exceeding the Act 2 Statewide Human Health standards for the soil to ground water pathway (Used Aquifer). TCE was the most prevalent compound detected in soil exceeding these standards. The results of this sampling indicate that the former degreaser area and the north plant area may represent a residual soil source of VOCs to ground water. As described above, the ground water VOC concentrations in the overburden zone in these areas are similarly elevated. It is also possible that the presence of VOCs in soil in this area may be affected by the fluctuating water table and sorption/desorption of VOCs to/from the soil.

4.3.7. VOC distribution conclusions

Based on the evaluation of the ground water concentrations of TCE, the most prevalent VOC in ground water and soil at the Site, the following technical conclusions are made with respect to the nature and migration of VOCs in ground water:

- The magnitude of VOC concentrations in ground water, and to a lesser degree in soil, suggest that a residual DNAPL source is present at the Site. The presence and distribution of VOC concentrations suggest that the overburden zone proximal to MW-2/MW-3/MW-19 and the former degreaser area is the primary residual source area and most likely DNAPL zone, if present at the Site.

- The ground water VOC concentrations on-site are generally higher in the overburden zone than the upper bedrock zone. The higher TCE/VOC ground water concentrations detected in the lower bedrock well (MW-17 and MW-19) ground water samples are likely a result of drilling and packer testing activities, particularly for MW-17. The MW-17 and MW-19 VOC concentrations may not be representative of the deeper bedrock ground water aquifer based on the existing data, as a result of the potential DNAPL presence and the drilling activities and hydraulic stresses associated with well installation.

- The ground water TCE/VOC concentration distribution in the overburden and bedrock zones are consistent with the ground water flow directions in these zones. The overburden VOC concentrations in ground water may reflect the prior movement of highly concentrated ground water in the saturated zone above bedrock or of potential DNAPL along the bedrock interface. For the upper bedrock zone, the VOC concentration distribution indicates a primary migration direction subparallel to formation strike generally towards MW-15.

- The surface water samples (one sampling event) suggest VOC impact to Little Valley Creek from Site ground water from the overburden or bedrock zones. These VOC impacts need to be further evaluated and confirmed. The ground water to surface water pathway proximal to the Site will be addressed as necessary by the interim remedial action (Sections 5 and 6).

- Based on well search information compiled and reported by BCM/Smith, an untreated water sample was collected from the one residential water supply well identified within one-mile of the Site. This sample revealed the presence of TCE, 1,1,1-TCA and 1,1-DCA in this ground water supply. Based on the well depth, the VOC concentration distribution and ground water flow direction, this impact likely originated from the Site; however, other sources of VOC impact are present in the area, which may potentially impact downgradient ground water supplies. The presence of the residential wellhead treatment system at this location eliminates this potential exposure pathway to the detected Site ground water VOCs.

5. Summary of interim remedial action program

5.1. General

Based on the site characterization of VOC impact to ground water, surface water and soil, an interim remedial action program for ground water will be implemented according to an expedited schedule to address the significant VOC concentrations in ground water. This section describes this interim program including the conceptual design. In order to expedite implementation, the remedial action activities incorporate key data gathering and final design tasks, many based on actual remedial performance, to eliminate the need for further site characterization programs prior to remedial action implementation.

Hydraulic containment via ground water extraction (pumping) and treatment was selected as the interim remedial technology for this Site based upon the nature and extent of ground water impact, and the availability and practicality of implementation of remedial technologies in this type of geologic formation. The potential presence of DNAPL in the source area(s) and inherent technical impractability and limitations of DNAPL removal was a factor in the technology selection.

The ground water pump and treat system has two objectives: 1) mitigate the further migration of VOC impacted ground water through hydraulic containment and 2) physically remove constituents of concern from the saturated zone through extraction. Ground water will be collected through submersible pumps placed in either vertical wells, horizontal wells or horizontal trenches. The ground water will then pumped to the surface where it will be treated and discharged at a permitted location.

The interim ground water extraction (GWE) program will consist of pumping ground water initially from the source area and areas of highest ground water contamination with sufficient extraction points to create a zone of hydraulic control. Ground water extraction will also be utilized to create a hydraulic barrier between the Site area and the adjacent stream to mitigate VOC discharge to this surface water feature. The extracted ground water will be passed through a treatment system to remove the VOCs to meet discharge limits, and then either re-injected or discharged to the adjacent sanitary or storm sewer system (with approval). Based on current information, it is anticipated that the treated ground water will be discharged to the local sanitary sewer.

5.2. Interim remedial action objectives

The remedial action objectives include 1) mitigation of further off-site migration of impacted ground water and the 2) reduction of the concentrations of VOCs in the ground water to levels considered achievable in the given subsurface environment with available and proven technology. The long-term goal will be compliance with the Act 2 standards. After implementation of the ground water extraction system and a sufficient performance evaluation/startup period, it is anticipated that the entrance of the Site into the Act 2 program will be initiated.

5.3. Outline of interim ground water remedial program

The interim remedial program for the Site has been designed to expedite the implementation of source control and hydraulic containment to mitigate further migration of VOCs in ground water. To accomplish a fast-track schedule for the interim source control/hydraulic containment system, the remedial program, which is presented in more detail in Section 6, provides for the collection and evaluation of Site constituents and hydraulic properties during final design, pilot and startup activities. Based on the established technologies for implementing hydraulic containment and treatment of VOCs and other secondary compounds and magnitude of VOC concentrations, further pre-design or site characterization programs will not be conducted prior to initiating the implementation process. Additional chemical and hydraulic data will be collected and evaluated during the startup and performance assessment of the initial stages of the hydraulic containment system to optimize and modify the design to effectively meet the identified remedial objectives.

To accomplish this expedited implementation, source control will be implemented through ground water extraction/hydraulic control in the on-site area proximal to the MW-2/MW-3 and MW-8/MW-9 well clusters. Based on the VOC distribution and occurrence of significant water producing zones, source control will be phased-in with one or more extraction wells pumping from the uppermost 100 ft of the bedrock zone, with monitoring in the shallow overburden and lower bedrock zones using existing and additional monitoring wells/piezometers. Ground water extraction from the upper 100 ft zone will include horizontal or vertical extraction wells from the overburden and shallow upper bedrock zone. A second phase extraction well(s) in this area may be utilized based on the hydraulic performance of the initial extraction well, in the 200 to 300 ft zone (yields of 25 to 100 gpm were encountered from the 250 - 300 ft zone when drilling on-site well MW-19) to achieve hydraulic control of the source area and area with highest VOC concentrations. The use of vertically separated extraction zones is necessary to avoid the potential downward movement of higher VOC concentrations in ground water from the overburden/upper bedrock ground water zones to lower bedrock ground water zones, while still providing sufficient hydraulic control of the primary migration pathways from the site.

In addition to the expedited implementation of ground water extraction in the area north of the plant (MW-2/MW-3/MW-19 area), ground water extraction will be expedited in the area to the east/northeast of the plant and upgradient of the stream to address higher VOC concentrations in the MW-8/MW-9 area and to create a hydraulic ground water - stream cutoff system. This element of the remedial system will be implemented based on the confirmation of VOC impact to the stream. As it is currently not known if TCE potentially may be entering the surface water feature from the overburden and upper bedrock zones, this implementation will include a fast-track investigation to establish the hydraulic relationship between the stream and the overburden/bedrock ground water zones, through the installation of 2 to 3 piezometers and hydraulic/geochemical monitoring. The piezometers will also be placed to provide important hydraulic information to monitor the ground water - stream cutoff system. These activities will be conducted coincident with source control/hydraulic containment in the area north of the plant. Subsequently, ground water extraction, using either extraction wells or horizontal trench, will be implemented in the east plant area and monitored to achieve hydraulic control. If wells are utilized (possibly due to ground water discharge from the bedrock zone), the extraction wells will be phased-in similar to the MW-2/MW-3/MW-19 source area in an effort to further optimize the remedial system.

Performance data from this interim extraction system will be utilized to complete the following:

- further assess the nature and presence of VOCs at depth in the bedrock aquifer, including the effect of drilling activities on the current VOC distribution.

- evaluate the hydraulic properties of the bedrock/overburden aquifer under continuous pumping, particularly the effects of secondary porosity (bedding planes, horizontal fractures) and the primary hydraulic conductivity direction away from the Site.

- modify/optimize the ground water treatment system based on actual performance data and in anticipation for increased flows (scale-up) with the potential addition of ground water extraction wells as necessary.

6. Interim remedial action program

The remaining section of this report presents the conceptual work plan for the Site interim ground water source control/hydraulic containment system. Based on the site characterization, ground water concentrations of VOCs have been identified in the shallow overburden and bedrock ground water zones at significant concentrations. TCE has also been detected in the adjacent surface water feature and private, domestic well water source potentially related to the Site. To address these ground water issues, the following sections describe the planned interim remedial action program for ground water.

Prior to the initiation of invasive, field activities, a complete Interim Remedial Action Work Plan (IRAW) will be prepared and submitted to the PADEP for review and comment. The IRAW elements are discussed in Section 6.2 below. The IRAW will provide the basis for field activities and sampling, and also facilitate discussions with the PADEP, as required, regarding ground water extraction/monitoring well installation and construction, permitting, monitoring activities and other related items.

A site-specific Health and Safety Plan (HASP) will be prepared for remedial activities. The HASP will be developed for O'Brien & Gere personnel only. Health and safety monitoring will be conducted independently by remedial contractor(s) working at the Site and O'Brien & Gere, in accordance with their individual Health & Safety Plans. The HASP identifies, at a minimum, health and safety personnel, protection levels, proposed remedial activities and emergency response procedures.

6.1. Hydraulic containment system

As described above, ground water will be extracted from the north plant area and east plant area (stream - ground water hydraulic barrier) as part of the expedited interim containment system. The final number and locations of extraction wells will be evaluated based on initial pilot-testing and the phased-in implementation and actual performance data, rather than extended site characterization activities.

Conceptually, it is anticipated that two, vertically spaced extraction points will be located proximal to MW-2/MW-3/MW-9 wells (north plant), with an estimated extraction rate of 30 to 60 gallons per minute (gpm), based on estimated well yields from previous drilling/sampling activities. As noted above, extraction points may include a horizontal extraction well in the overburden/shallow upper bedrock, within the upper 100 ft. The use of horizontal technology will be evaluated with qualified drilling contractors based on Site conditions during the final interim design stage (Section 6.8). Additional extraction wells or a trench system will be located on the east side of the plant (upgradient of stream) with an additional flow rate of 30 gpm. Therefore, an initial extraction rate of 60 to 90 gpm is anticipated from the source control/containment system. The actual extraction rate to achieve hydraulic control will be identified based on performance monitoring.

Ground water extracted will be transmitted to an on-site treatment system through underground piping and piping within the building. The ground water extraction wells/trench will be equipped with instrumentation to continuously monitor flow (instantaneous and cumulative), system pressure and hydraulic head. The proposed location of the treatment system will be within the northeast corner of the building. Placing the system within the heated building will improve system performance, provide easier access to required utilities and reduce maintenance and installation costs.

The hydraulic effects (i.e. capture zone), the mass of VOCs removed, and response of the VOC ground water concentrations to extraction will be evaluated through hydraulic monitoring and ground water sampling. The monitoring network will consist of existing and newly installed monitoring wells/piezometers. The monitoring network design will be modified based on the performance data.

Implementation of the interim ground water extraction and treatment system will be expedited through conduct of a startup period over the first month of operation. Conceptual design criteria, based on previous, physical, hydraulic and chemical data, have been used to develop this plan. The proposed ground water remediation system may be modified, as necessary, based on system startup activities in an effort to further optimize system performance and meet the remedial objectives. Potential modifications include alterations of the recovery locations or treatment system components.

6.1.1. Capture zone evaluation

The ground water extraction system of the interim ground water remediation system includes several extraction wells based on the conceptual design. Preliminarily, the anticipated capture zone area for a vertical extraction well is estimated as follows:

<u>Capture Zone Estimation</u> - Based on information from Sloto (1990), an average value for transmissivity of 1,000 ft^2/day is estimated for the uppermost 250 ft of aquifer. This value was used to estimate the area of hydraulic capture for a single extraction well based on the regional (nonpumping) hydraulic gradient and anticipated extraction rate, using the uniform flow field approach (Todd, 1959). The upgradient maximum width and downgradient extent (stagnation point) were calculated using the following uniform flow analytical equations:

$$Y = Q/TI$$
$$Xo = Q/(2 \Pi T I)$$

Y = upgradient width of the hydraulic capture zone (feet)
Xo = downgradient distance to stagnation point (feet) from the extraction well
Q = extraction rate (ft^3/day) = 5,775 ft^3/d (30 gpm)
T = aquifer transmissivity = 1,000 ft^2/d (250 ft aquifer)
I = hydraulic gradient (ft/ft) = 0.04

Using the above, the following values were calculated:

Y = 144 feet
Xo = 23 feet

These calculations provide an initial estimate of the capture zone for a vertical extraction well assuming a flow rate of 30 gpm, assuming isotropic/homogeneous conditions. Given the nature of the limestone bedrock and secondary porosity features, the actual extent of hydraulic influence (drawdown) and the resultant capture zone cannot be accurately quantified until implementation and initial performance monitoring. It is anticipated that extraction in the limestone aquifer from the more significant water bearing zones will result in hydraulic capture zones larger than predicted by the above calculation. The actual capture zone area will be assessed periodically during the interim remedial action program.

6.1.2. Recovery equipment and piping

The recovery well will be equipped with an electrical submersible pump. The pump will be approximately 4 inches in diameter with a stainless steel housing, and will be designed for continuous pumping within the specified operating range (to a maximum of 30 gpm) with the required discharge pressure head. The pumping rate will be manually controlled by a throttling valve to obtain the desired withdrawal rate. The pumping level will be regulated electronically by a control system (level sensors) to maintain a specified drawdown and prevent lowering of the water level into the pump intake. The recovery well head will be located in a approximate 2 ft by 2 ft subgrade vault to house the level transmitter.

The recovery piping will be, at a minimum, 2 inch diameter, Schedule 80 PVC or SDR-11 HDPE pipe. It will be buried approximately three feet below grade or within a concrete pipe trench and will be connected to the well by a pitless adapter. A low voltage heat trace will be installed on above grade recovery piping that is not indoors or within 3 ft of ground surface for freeze protection. Electrical and control conduit will also be included in the trench and wall penetrations to the main building. The conduit will contain conductors to supply power and control circuits to the submersible pumps and level sensors. The system layout is depicted in Figure 14.

6.2. Ground water treatment system

The design of the proposed ground water treatment system was based on:

- projected ground water recovery rates;
- historic site ground water quality data; and
- hydraulic loading analysis and local sanitary sewer system discharge limits.

Based on these criteria, the remedial system will be designed to remove VOCs (primarily TCE and 1,1,1-TCA) from the extracted ground water at an average flow rate of 60 gpm with an influent VOC concentration of 400 ppm total VOCs. Treated water will be discharged to the local POTW

(Valley Forge Water Authority) through the on-site sanitary sewer system. No treatment for metals or other inorganics has been assumed based on available analytical data and the anticipated POTW discharge limits.

<u>Influent Quality</u> -The ground water sample collected immediately following the MW-19 pumping was used to assess influent water quality under pumping conditions and to form the basis of the remedial approach. Based on this conservative profile, an aeration treatment unit was designed to treat an influent concentration of 400 ppm of total VOCs to applicable discharge limits. This system design and sizing were also based on the specific VOCs/levels present. Table 8 provides a flow-weighted average and maximum concentration for each VOC historically detected.

<u>Aeration Unit Conceptual Design and Layout</u> - Based on the hydraulic analysis and influent quality profile, the planned primary treatment process to remove VOCs from influent ground water will be forced-draft, counter-current air stripping. This air stripping unit will be a low-profile, shallow tray model sized to meet the discharge effluent criteria. The stripper will be located within the existing building. Ground water will enter the sized air stripper at the top and flow by gravity through a series of trays prior to a collection sump at the bottom of the unit as air is forced (induced) upwards through the trays by a blower. By forcing air through the water, dissolved VOCs will volatilize and be transferred from the water to the off-gas air stream. The air stripper will be sized to meet applicable effluent criteria and an operating flow rate (hydraulic loading) in the aeration unit of up to 175 gpm to allow for future expansion of the recovery well network, if required.

The VOC concentrations in the off-gas from the air stripper were estimated based on a 60 gpm flow rate and speciated mass average VOC concentrations for a preliminary evaluation of the need for off-gas controls and application for air permitting. The PADEP air quality regulations will require off-gas control based on the anticipated VOC removal rates.

For this system, a catalytic oxidizer equipped with a caustic scrubber has been included to treat the chlorinated VOCs in the off-gas. The scrubber may be required to control the HCl formed during the breakdown of the chlorinated VOCs in the oxidizer. The design off-gas flowrate will be approximately 900 cfm.

A preliminary evaluation of inorganic ground water quality data indicate that levels of iron and manganese should not require pretreatment prior to discharge to the local POTW. A 5,000 gallon sedimentation/equalization tank and strainer have been assumed prior to the air stripping unit to equalize the influent flow rate and drop out/reduce potential settleable solids. The equalization tank will be equipped with a hood with induced air flow connected to the air stripper blower to control and treat potential fugitive emissions from this tank. If necessary in the future, this system can be adapted if the need arises for pretreatment of inorganics to reduce equipment fouling or to meet discharge permit requirements.

Treatment System Operation - Untreated ground water will be pumped from the recovery well(s) to the sedimentation/equalization tank inside the Site building. A transfer pump will pump the water from the equalization tank through a strainer or bag filter to the low profile air stripper and will be controlled by high/low level switches. Following treatment in the air stripper, the effluent will be discharged to the on-site sanitary sewer line. A flow meter will be located on the influent water line from the extraction wells/trench. The meter will record the flow rate of ground water processed by the treatment system (in gpm). A totalizer will be located on the effluent discharge line to record the total volume of water treated by the system (in gallons).

During the initial startup phase, extracted ground water will be pumped from the equalization tank through two liquid phase granular activated carbon (GAC) canisters arranged in series for removal of VOCs prior to the gravity discharge of the treated water to the on-site sewer. A second pump will only be needed for this GAC step. This treatment system will be utilized in lieu of the air stripper during initial startup only until ground water withdrawal rates and water quality can be better defined. Figure 14 presents the conceptual layout of the treatment system. Figure 15 is a conceptual process flow schematic showing the flow through the ground water treatment system. The entire treatment system will be located inside the existing Site building, including installation of electrical power and system backwash solutions. Electric space heating will be added to the building if required to keep conditions above freezing in the winter months.

Systems Control and Alarms - Maintaining an appropriate water level (drawdown) in the extraction wells will provide for required zone of capture. A Pump-Tech® level controller (or similar device) will be incorporated into the recovery well system and control panel to prevent over pumping of the well. In the event of a recovery well system failure (such as an unlikely severe drop in the water level in the recovery well), the treatment and process pumps will be turned off followed by a specified time delay. The time delay will be sufficient to allow the treatment of water remaining in the air stripper unit. Additionally, if the air stripper blower fails (blower pressure falls outside of the operating range), the ground water treatment system will be shut down. The transfer pump will operate based on the level switches in the equalization tank. In the equalization tank, as well as the air stripper sump, there will be level switches that will indicate improper system operation and shut-down the remediation system accordingly. Alarms indicating a system shut down will result in a visible alarm at the plant.

6.3. Treated ground water discharge

Three alternatives were evaluated for discharge of treated ground water. The alternatives which require permits included:

- discharge to ground water
- discharge to surface water
- discharge to the POTW

Based on these considerations, the most reliable and feasible option for the discharge of treated site ground water is discharge to the POTW via the on-site sanitary sewer line. It is anticipated that following approval, a discharge pipe will extend from the treatment unit, through the eastern building wall into an underground trench and be connected to the nearby sanitary sewer manhole located along the southeastern boundary of the property.

6.4. Permits

6.4.1. Federal permits

Based on the constituents of concern, impacted media, and remedial actions described above, no federal permits will be required except those which fall under the jurisdiction of the PADEP.

6.4.2. State/agency permits

Based on the proposed remedial actions described above and regulatory requirements, it is anticipated that several state permits will be required. The following list summarizes permits that may be required for the planned remedial actions:

- Permit to Construct/Install/Alter Air Quality Control Apparatus/ Equipment;
- Certificate to Operate Air Quality Control Apparatus/Equipment;
- Chester County Well Drilling Permit;
- Delaware River Basin Commission - Ground Water Withdrawal Permits; and,
- Valley Forge Water Authority Discharge Permit, Permit Modification or Discharge Authorization.

6.4.3. Local permits

Local permitting requirements required by the planned remedial actions will be identified. The need for the following local permits will be investigated prior to initiation of remedial actions:

- Electric Permit;
- Plumbing Permit;
- Building Permit; and,
- Fire Protection Permit.

6.5. Waste management

The wastes generated from the ground water treatment system will primarily entail the exhausted carbon and caustic scrubbing liquid blowdown from the oxidizer on a periodic basis. This scrubbing liquid will be neutralized and either discharged to the POTW or transported off-site by a tanker to a permitted treatment facility, depending on the characterization.

Residuals from periodic equipment cleaning and captured in the equalization/settling tank and strainer or bag filter, if present, will be containerized, characterized and shipped off-site for disposal on an as-needed basis.

6.6. Pilot/temporary system startup

The recovery and treatment system described in this section is based on certain assumptions for characterization and flow rate. Prior to full-scale installation, a one to two week pilot (temporary) system start-up will occur to refine the basis of design parameters to further optimize final system performance. The pilot system will include one or more extraction points located within the MW-2/MW-3 source area and north plant area. The pilot system will be operated upon installation of the recovery well(s). The system will include submersible pumps and temporary piping connected to two 5,000-gal liquid granular activated carbon (GAC) canisters in series. The treated water will be sent to the POTW. Confirmation sampling for the POTW authorization during startup will consist of samples from a valve situated between the two carbon canisters.

Data collected during the start-up period will include maximum sustainable flow rate from each well, VOC and inorganic water quality data (influent/effluent) and ground water level measurements from the recovery wells and piezometers. The data will be used primarily to finalize the basis of design/sizing for the permanent air stripper and off-gas treatment system. The data will also be used to support the final air permits and POTW discharge application for the permanent system.

Quarterly sampling and monitoring events will include sampling of ground water from site and off-site monitoring wells and stream samples for field parameters (pH, specific conductance, dissolved oxygen, and temperature) and analysis of the samples for VOCs by Method 8260 (plus library search). In addition, a full round of water level measurements from ground water monitoring wells will be periodically collected, including weekly during the first month of extraction and monthly thereafter. The sampling frequency will be evaluated based on the performance and analytical data.

Sampling of the treatment system will include collection of one influent ground water sample directly downstream of the recovery well, one water sample prior to the air stripper and one final effluent water sample prior to discharge to the sanitary sewer system. In addition, the air stripper off-gas stream will be monitored pursuant to requirements under the air discharge permit. These influent and effluent samples will also be sampled and analyzed for field parameters and VOCs by EPA Method 8260, as well as iron, manganese, alkalinity, hardness, TDS, TSS and any additional required parameters for discharge. Additional effluent analysis will be completed in accordance with the effluent discharge permit, as required.

6.7. Reporting

Subsequent to the initiation of the interim remedial action program, quarterly progress reports will be prepared and submitted to PADEP in accordance with established criteria. The following information will be documented within the progress reports:

- reporting of remedial actions, data and evaluations accomplished during the reporting period;
- proposal of deviations from or modifications to the IRAW;
- reporting of problems or delays in the implementation with proposed corrections and revised schedule;identification of the remedial actions for the next reporting period;
- annual presentation of the actual costs of remediation incurred to date;
- additional supporting documentation that is available.

6.8. Implementation schedule

The implementation schedule for the interim ground water remedial program is presented in Figure 16. As shown, the implementation schedule consists of the following three major tasks as follows:

- Interim Final Design: This task includes the IRAW, pilot test design, permitting activities, extraction/monitoring/piezometer well installation, baseline ground water sampling event, monthly hydraulic monitoring, bench scale testing and the stream-ground water evaluation. It is estimated this task will require 4 months for completion (excluding ongoing hydraulic monitoring).

- Remedial System Startup: This task includes pilot testing, equipment design, procurement and installation, and startup/evaluation activities. This task is estimated to be completed in 9 months.

- Operation & Maintenance (O&M): The O&M task includes weekly/monthly hydraulic monitoring, ground water and surface water sampling, periodic performance evaluation and progress reports. As shown in the attached schedule, O&M is projected to begin in September 1999.

7. References

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Table 10
Proposed Treatment System - Flow Weighted
Average and Maximum VOC Influent Concentrations
Bishop Tube Site
Frazer, Pennsylvania

	Proposed Extraction Well Near MW-3		Proposed Extraction Well Near MW-9		Anticipated Treatment System Influent Concentrations*	
Compound	Average Concentration	Maximum Concentration	Average Concentration	Maximum Concentration	Average Concentration	Maximum Concentration
PCE	32.3	124	10.3	40.6	21.3	82.3
TCE	163586.3	680000	49663.2	107000	106624.8	393500.0
c-1,2-DCE	ND	ND	ND	ND	NA	NA
t-1,2-DCE	829.2	2620	465.4	1150	647.3	1885.0
1,1-DCE	221.2	613	62.8	116	142.0	364.5
Vinyl Cl	ND	ND	5.8	14.4	2.9	7.2
1,1,2-TCA	ND	ND	ND	ND	NA	NA
1,1,1-TCA	4440.2	11700	922.3	1420	2681.3	6560.0
1,2-DCA	1.0	6.1	0.4	2.4	0.7	4.3
1,1-DCA	54.7	180	16.3	93.3	35.5	136.7
Chl. Ethane	ND	ND	ND	ND	NA	NA
Meth. Cl	360.8	2160	22.1	98.6	191.4	1129.3
Chloroform	19.7	118	0.7	4.3	10.2	61.2
1,4-DCB	ND	ND	ND	ND	NA	NA
CB	ND	ND	ND	ND	NA	NA
TCFM	15.4	92.5	ND	ND	7.7	46.3
DBCM	ND	ND	ND	ND	NA	NA
Bromoform	ND	ND	ND	ND	NA	NA
BDCM	ND	ND	1.2	5.3	0.6	2.7
Bromometh.	ND	ND	0.5	4.4	0.2	2.2

Concentrations are in ug/l

* - Assumes Extraction Wells operate at 30 gpm each for a treatment system total of 60 gpm
ND - Not Detected
NA - Not Applicable

Compound Abbreviations:

1,1-DCA - 1,1 Dichloroethane
1,2-DCA - 1,2 Dichloroethane
1,1,2-TCA - 1,1,2 Trichloroethane
1,1,1-TCA - 1,1,1 Trichloroethane
1,4-DCB - 1,4 Dichlorobenzene
c-1,2-DCE - cis-1,2 Dichloroethene
t-1,2-DCE - trans-1,2 Dichloroethene
1,1-DCE - 1,1 Dichloroethene
TCE - Trichloroethene
PCE - Tetrachloroethene
CB - Chlorobenzene
TCFM - Trichlorofluoromethane
DBCM - Dibromochloromethane
BDCM - Bromodichloromethane

July 29, 1998

Table 9
Soil Sampling Results Summary
Bishop Tube Site
Frazer, Pennsylvania

Area	Number of Borings/Samples	Sample Depth Range (feet below grade)	Analyses (Method)	Soil Samples/Compounds Exceeding Act 2 Standards			Act 2 Statewide Health Standard*
				Compound	Number of Soil Samples Exceeding	Highest Concentration (ppm)	
South of Plant/Former Impoundment Area (B1, B2, B2A, B3)	4/7	4.5 - 20.0	VOCs (8010)	None	None	N/A	N/A
			Metals (SW-846): Chromium, Copper, Nickel, Zinc	None	None	N/A	
East of Plant/Former Impoundment Area (B4, MW-5)	2/5	4.5 - 16.5	VOCs (8010)	None	None	N/A	N/A
			Metals (SW-846): Chromium, Copper, Nickel, Zinc	None	None	N/A	
North of Plant/ Former TCE AST (B-5, B-6, B-7, B-9, MW-10A, MW-11, MW-12)	7/20	1.5 - 15.0	VOCs (8010)	1,1-DCE Methylene Chloride 1,1,1-TCA TCE	5 2 2 8	>20 >1 >50 >20	0.7 0.5 20 0.5
Inside Plant/Former Degreaser (B-10, B-11, B-12)	3/6	1.5 - 6.5	VOCs (8010)	1,1-DCE Methylene Chloride PCE 1,1,1-TCA TCE	1 1 1 1 4	39.8 1.44 10.2 36 3280	0.7 0.5 0.5 20 0.5

*Act 2 Statewide Health Standard is the soil to ground water pathway standard for Used Aquifer (Non-Residential), using higher of generic and 100X ground water MSC standard.

July 28, 1998

Table 8
Summary of MW-19 TCE Ground Water Sampling Results
Bishop Tube Site
Frazer, Pennsylvania

Date of Test/Sample	**Open Well Interval (ft bg)** (Interval from Bottom of Casing to Bottom of Open Hole)	**Packered Interval (ft bg)**	**TCE (ppm) - Field GC** (range during pumping)	**TCE (ppm) - Laboratory Sample**	**Comments**
04/07/1995	90 - 150	111 - 150	13.08 - 17.33 (4 samples)	none	Packered interval dewatered (flow = 1.4 gpm)
04/11/1995	90 - 200	165 - 200	14.95 - 17.99 (4 samples)	250	163 ft of drawdown (flow = 0.85 gpm) Interval above packer: 3 ft drawdown
04/13/1995	90 - 300	275 - 300	22.52 - 38.31 (5 samples)	400	Pumped at 25 gpm - 7.2 ft drawdown Interval above packer: 4 ft drawdown
12/01/1995	300 - 406	350 - 406	115 (1 sample)	none	Pumped at 4 gpm - 108 ft drawdown
12/08/1995	*300 - 500*	*420 - 500*	*N/A*	*none*	*Pressure head due to slug tests did not decline/equilibrate-* No flow indicated and test was aborted
	300 - 500	399 - 500	56 - 74 (*3 samples*)	none	Pumped at 1 - 6 gpm - 210 ft drawdown
Bottom Sample 01/04/1996	300 - 500	N/A	N/A	380	Grab sample (no purging)
Ground Water Sampling 01/24/1996	300 - 422	N/A	N/A	510	Purged 330 gals., 72 ft drawdown Depth to water = 65.98 ft at sampling
30 hr. Pump Test Ground Water Sampling					
02/13/1996 - 1 hr.	300 - 422	N/A	N/A	1200	Pumped at 3.6 gpm, 215 ft of drawdown Sampled through pump set at 330 ft bg
02/13/1996 - 15 hr.	300 - 422	N/A	N/A	1000	
02/14/1996 - 29 hr.	300 - 422	N/A	N/A	660	

Table 7
Summary of MW-17 TCE Ground Water Sampling Results
Bishop Tube Site
Frazer, Pennsylvania

Date of Test/Sample	Open Well Interval (ft bg) (Interval from Bottom of Casing to Bottom of Open Hole)	Packered Interval (ft bg)	TCE (ppm) - Field GC (range during pumping)	TCE (ppm) - Laboratory Sample	Comments
04/06/1995	84 - 150	120 - 150	9.375 - 14.96 (10 samples)	none	TCE decreases with pumping Packered interval dewatered
04/10/1995	84 - 200	171 - 200	7.573 and 9.494 (2 samples)	none	TCE increased with pumping Packered interval dewatered
12/07/1995	204 - 404	343 - 404	62 - 317 (3 samples)	300	350 ft of drawdown
	204 - 404	204 - 300	145 (1 sample)	none	-
Bottom Sample 01/04/1996	204 - 404	N/A	N/A	350	Grab sample (no purging)
Ground Water Sampling 01/23/1996	204 - 300	N/A	N/A	110	Purged 1350 gals., 67 ft drawdown *Depth to water ≈ 28.18 ft at sampling*

Table 6
Off-Site Area Monitoring Wells
Summary of Volatile Organics in Ground Water
Bishop Tube Site
Frazer, Pennsylvania

Monitoring Well ID / Monitored Depth Interval**		Volatile Organic Compound																	
	Compound:	PCE	TCE	c-1,2-DCE	t-1,2-DCE	1,1-DCE	Vinyl Cl	1,1,1-TCA	1,2-DCA	1,1-DCA	Chl. Ethane	Meth. Cl	Chloroform	1,4-DCB	CB	1,2-DCP	TCFM	DBCM	Bromoform
	Statewide Standard (1)	5	5	70	100	7	2	200	5	27*	58000	5	100	75	100	5	2000	100	100
	Sample Date																		
MW-13	08/29/89	23.5	10600	-	110	164	<1	3470	<1	33.6	<1	<1	<1	<1	<1	<1	<1	<1	<1
27 - 37	09/28/89	<10	863	-	12.3	22.6	<10	490	<10	<10	<10	19.2	<10	<10	<10	<10	<10	<10	<10
(rock)	01/23/96	<500	2900	-	<500	<500	<500	1400	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
MW-14	08/29/89	<1	666	-	12.5	16.6	<1	287	<1	8.9	<1	<1	<1	<1	<1	<1	<1	<1	<1
5 - 15	(duplicate)	<1	751	-	10.6	13.2	<1	323	<1	7.3	<1	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	09/28/89	31.3	13800	-	140	229	<10	3930	<10	35.9	<10	16.7	<10	<10	<10	<10	<10	<10	<10
	01/23/96	<10	1200	-	<10	14	<10	310	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
MW-15	08/29/89	39.3	44400	-	570	564	<1	7800	<1	53.8	<1	1.8	<1	<1	<1	<1	<1	<1	<1
68 - 78	09/28/89	97.6	116000	-	446	789	<1	10100	<1	66.4	<1	<1	4.9	<1	<1	<1	<1	<1	<1
(rock)	01/23/96	<500	1400	-	<500	<500	<500	4800	<500	<500	<500	<500	<500	<500	<500	380 J	<500	<500	<500
MW-16	08/29/89	7.4	4580	-	169	140	<1	2340	41.8	419	18.6	<1	<1	<1	<1	<1	<1	<1	<1
7 - 21	09/28/89	3	1144	-	110	103	<1	1320	<1	265	5.7	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	01/23/96	<50	650	-	<50	<50	<50	920	<50	<50	<50	<50	<50	<50	<50	110	<50	<50	<50
	(duplicate)	<50	660	-	<50	<50	<50	930	<50	<50	<50	<50	<50	<50	<50	90	<50	<50	<50
MW-17	01/23/96	<5000	110000	-	<5000	<5000	<5000	50000	<5000	<5000	<5000	<5000	<5000	<5000	<5000	13000	<5000	<5000	<5000
200 - 301																			
(rock)																			

Concentrations in ug/l (ppb)

(1) - Medium Specific Concentration for Used Aquifer
* - residential used aquifer where notated
** - feet below grade
(-) - Not analyzed
J - Estimated concentration below method detection limit
Note: Methylene Chloride (1.2 ppb) and TCE (12.7 ppb) were detected in the trip blank submitted on 9/28/98.
Methylene Chloride (1.2 ppb) and TCE (3.5 ppb) were detected in the field blank submitted on 9/28/98.

1,2-DCA - 1,2 Dichloroethane
1,2-DCP - 1,2 Dichloropropane
1,1,1-TCA - 1,1,1 Trichloroethane
1,4-DCB - 1,4 Dichlorobenzene
1,1-DCE - 1,1 Dichloroethene
c-1,2-DCE - cis-1,2-Dichloroethene
t-1,2-DCE - trans-1,2-Dichloroethene
TCE - Trichloroethene
PCE - Tetrachloroethene
CB - Chlorobenzene
1,1-DCA - 1,1 Dichloroethane
CF - Chloroform
TCFM - Trichlorofluoromethane
DBCM - Dibromochloromethane

July 29, 1998

Table 6
East Side of Plant Monitoring Wells
Summary of Volatile Organics in Ground Water
Bishop Tube Site
Frazer, Pennsylvania

Monitoring Well ID / Monitored Depth Interval**	Compound:	Volatile Organic Compound																		
	Compound:	PCE	TCE	c-1,2-DCE	t-1,2-DCE	1,1-DCE	Vinyl Cl	1,1,1-TCA	1,2-DCA	1,1-DCA	Chl. Ethane	Methylene Cl	Chloroform	1,4-DCB	CB	TCFM	DBCM	BDCM	Bromoform	Bromometh
	Statewide Standard (1)	5	5	70	100	7	2	200	5	110*	58000	5	100	75	100	2000	100	100	100	10
	Sample Date																			
MW-1	09/15/87	<1	5.1	-	<1	<1	<1	1.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
24 - 48	08/29/89	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
(rock)	11/27/89	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	03/22/90	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	07/18/90	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW-4	09/15/87	73.9	421	-	287	11.7	58.8	19.4	<1	15 6	<1	<1	5.7	<1	<1	<1	<1	<1	<1	<1
7 - 20	08/29/89	24.9	1110	-	316	5.5	<1	18 9	<1	11.2	<1	<1	<1	<1	<1	42.2	<1	<1	<1	<1
(unconsolidated)	11/27/89	12.5	457	-	158	4.1	23 3	17	<1	10 9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	03/22/90	75.6	1450	-	538	6 5	74.2	15.3	<5	21.9	<5	5 2	<5	<5	<5	<5	<5	<5	<5	<5
	07/18/90	24 4	823	-	<10	<10	26	<10	<10	11.3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	01/24/96	23	490	-	<10	<10	<10	13	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
MW-5	09/15/87	<1	63.5	-	407	6.4	28	6.1	8.4	22 6	13.2	<1	<1	<1	<1	<1	<1	<1	<1	<1
10 - 20	08/29/89	<1	<1	-	18.5	<1	4 2	<1	<1	16 6	3 3	<1	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	11/27/89	<1	2.2	-	11.2	<1	<1	1.2	<1	15.4	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
	03/22/90	<1	10.6	-	34.3	1.5	3.9	36.1	<1	18 9	3.3	<1	<1	<1	<1	<1	<1	<1	<1	<1
	07/18/90	<1	13.6	-	<1	<1	<1	4.1	<1	26.5	3 2	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW-6	09/15/87	3	255	-	86.2	13.1	13	94.7	5.4	14.9	<1	<1	<1	<1	<1	1.3	<1	<1	<1	<1
11 - 21	08/29/89	<1	526	-	82.4	6.5	8 7	70 1	<1	9.9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	11/27/89	2.3	482	-	68.8	5.8	6 8	71.1	1 9	9 6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	03/22/90	<5	630	-	101	5.3	7.5	55.2	<5	13.1	<5	6 1	<5	<5	<5	<5	<5	<5	<5	<5
	07/18/90	<10	788	-	<10	<10	<10	61.6	<10	11.7	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
MW-7	09/15/87	4.4	346	-	343	7.2	<1	24.8	<1	17.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
10 - 20	08/29/89	<1	78.9	-	49.3	<1	<1	2.5	<1	1.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	11/27/89	3.7	413	-	452	<1	<1	16.3	<1	11 8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	03/22/90	<5	257	-	395	<5	<5	8.1	<5	11 6	<5	7.3	<5	<5	<5	<5	<5	<5	<5	<5
	07/18/90	<5	462	-	<5	<5	<5	10.8	<5	10.2	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
MW-8	09/15/87	6.5	628	-	477	64.2	171	355	9.6	12.8	<1	<1	13.9	<1	<1	<1	13.1	<1	<1	<1
8 - 18	08/30/89	9.3	2860	-	803	37.7	86.8	399	<1	3.2	16.6	1.6	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)	(duplicate)	9.2	2750	-	798	37.7	60.8	395	<1	2.8	<1	1.1	<1	<1	<1	<1	<1	<1	<1	<1
	11/27/89	8.3	10100	-	934	23	128	309	<1	3.3	<1	<1	<1	<1	<1	<1	2.8	<1	<1	<1
	03/22/90	<50	52200	-	276	50	<50	755	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	07/18/90	<50	63200	-	<50	<50	<50	684	<50	<50	<50	93	<50	<50	<50	<50	<50	<50	<50	<50
MW-9	09/15/87	11	739	-	119	90.7	12.1	390	2 4	93.3	<1	<1	4 3	<1	<1	<1	<1	<1	<1	<1
48 - 63	08/30/89	14.9	4130	-	482	63.3	14.4	621	<1	20.6	<1	2 4	<1	<1	<1	<1	<1	5.3	<1	<1
(rock)	11/27/89	40 6	24100	-	1150	79.8	13.6	1130	1	15.5	<1	<1	1.9	<1	<1	<1	<1	5.3	<1	4 4
	(duplicate)	26.4	27900	-	1080	112	12.1	1060	<1	17 6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	03/22/90	<50	100000	-	668	103	<50	1310	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	(duplicate)	<50	107000	-	690	116	<50	1420	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	07/18/90	<50	84300	-	<50	<50	<50	1110	<50	<50	<50	98 6	<50	<50	<50	<50	<50	<50	<50	<50
	(duplicate)	<50	96500	-	<50	<50	<50	970	<50	<50	<50	98 1	<50	<50	<50	<50	<50	<50	<50	<50
	01/24/96	<50	2300	-	<50	<50	<50	290	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Concentrations in ug/l (ppb)

(1) - Medium Specific Concentration for Used Aquifer
* - nonresidential used aquifer where notated
** - feet below grade
(-) - Not analyzed
J - Estimated concentration below method detection limit

1,2-DCA - 1,2 Dichloroethane
1,1-DCA - 1,1 Dichloroethane
1,1,1-TCA - 1,1,1 Trichloroethane
1,4-DCB - 1,4 Dichlorobenzene
PCE - Tetrachloroethene

c-1,2-DCE - cis-1,2-Dichloroethene
t-1,2-DCE - trans-1,2-Dichloroethene
1,1-DCE - 1,1 Dichloroethene
TCE - Trichloroethene

CB - Chlorobenzene
TCFM - Trichlorofluoromethane
DBCM - Dibromochloromethane
BDCM - Bromodichloromethane

Table 2
Field GC Headspace Results for Packer Test Samples
Bishop Tube Site
Frazer, Pennsylvania

Monitoring Well	Date of Test/Sample	Open Well Interval * (ft bg)	Packered Interval (ft bg)	Total VOCs (ppm) Field GC Headspace	TCE (ppm) Field GC - (range during pumping)
MW-17	04/06/1995	84 - 150	120 - 150	Start of Test: 15.0 Middle of Test: 13.2 End of Test: 12.8	9.375 - 14.96 (10 samples)
	04/10/1995	84 - 200	171 - 200	NA NA NA	7.573 and 9.494 (2 samples)
	12/07/1995	204 - 404	343 - 404	Start of Test: 492.6 Middle of Test: 67.4 End of Test: 280	62 - 317 (3 samples)
	12/07/1995	204 - 404	204 - 300	Start of Test: NT Middle of Test: NT End of Test: 145.0	145 (1 sample)
MW-19	04/07/1995	90 - 150	111 - 150	Start of Test: 14.0 Middle of Test: 13.6 End of Test: 17.3	13.08 - 17.33 (4 samples)
	04/11/1995	90 - 200	165 - 200	Start of Test: 16.5 Middle of Test: 18.0 End of Test: 19.8	14.95 - 17.99 (4 samples)
	04/13/1995	90 - 300	275 - 300	Start of Test: 22.5 Middle of Test: 27.6 End of Test: 38.3	22.52 - 38.31 (5 samples)
	12/01/1995	300 - 406	350 - 406	Start of Test: NT Middle of Test: NT End of Test: 115.0	115 (1 sample)
	12/08/1995	300 - 500	420 - 500	NA NA NA	NA
	12/08/1995	300 - 500	399 - 500	Start of Test: 74.0 Middle of Test: 56.0 End of Test: 58.0	56 - 74 (3 samples)

NA - Not Available
NT - Not Tested
* - Interval from Bottom of Casing to Bottom of Open Hole

July 29, 1998

Table 6
Former Degreaser/AST Area Monitoring Wells
Summary of Volatile Organics in Ground Water
Bishop Tube Site
Frazer, Pennsylvania

Monitoring Well ID / Monitored Depth Interval**		Volatile Organic Compound																		
	Compound:	PCE	TCE	c-1,2-DCE	t-1,2-DCE	1,1-DCE	Vinyl Cl	1,1,2-TCA	1,1,1-TCA	1,2-DCA	1,1-DCA	Chl. Ethane	Meth. Cl	CF	1,4-DCB	CB	TCFM	DBCM	Bromoform	BDCM
	Statewide Standard (1)	5	5	70	100	7	2	5	200	5	110*	58000	5	100	75	100	2000	100	100	100
	Sample Date																			
MW-2	*09/15/87*	*21.5*	*46000*	-	*426*	*467*	*1.7*	*<1*	*80000*	*21.9*	*221*	*3.4*	*9.1*	*291*	*<1*	*<1*	*1.5*	*<1*	*<1*	*<1*
15 - 24	01/13/88	<25	5600	-	1080	606	<25	<25	8360	<25	15	<25	<25	<25	<25	<25	<25	<25	<25	<25
(rock)	04/08/88 - BCM	325	26400	-	1720	<100	<1	<100	3730	<100	<100	<100	<1	<100	<100	<100	<1	<100	<100	<100
	- AGES	*46*	*5010*	-	*3321*	*366*	*<1*	*<1*	*2829*	*<1*	*40*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
	08/30/89	85.6	36100	-	685	611	<10	<10	17300	1050	157	<10	10.9	<10	<10	<10	<10	<10	<10	<10
	09/28/89	102	48900	-	623	1190	<100	<100	16500	<100	157	<100	152	<100	<100	<100	<100	<100	<100	<100
MW-3	09/15/87	43.6	74000	-	463	266	<1	<1	593	6.1	32.4	<1	<1	<1	<1	<1	<1	<1	<1	<1
8 - 13.5	01/13/88	<1	19304	-	2620	165	<1	<25	4952	<25	<25	<25	2.4	<25	<25	<25	92.5	<25	<1	<1
(unconsolidated)	04/08/88 - BCM	12.4	6460	-	708	180	<1	<1	11700	<1	180	<1	2.2	118	<1	<1	<1	<1	<1	<1
	- AGES	14	2754	-	948	613	<1	<1	3536	<1	102	<1	<1	<1	<1	<1	<1	<1	<1	<1
	08/30/89	124	199000	-	236	103	<1	<1	3130	<1	14	<1	<1	<1	<1	<1	<1	<1	<1	<1
	09/28/89	<1000	680000	-	<1000	<1000	<1000	<1000	2730	<1000	<1000	<1000	2160	<1000	<1000	<1000	<1000	<1000	<1000	<1000
MW-10	08/30/89	<1	93.8	-	4.6	<1	<1	<1	84.2	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1
5 - 15	09/28/89	<1	244	-	9.9	2.6	<1	<1	84.4	<1	4.3	<1	2.8	<1	<1	<1	<1	<1	<1	<1
(rock)	(duplicate)	1	227	-	14.2	4.9	1.5	<1	112	<1	6.3	<1	2.8	<1	<1	<1	<1	<1	<1	<1
MW-11	08/30/89	32.1	17100	-	1970	600	<1	<1	20700	103	900	<1	15	<1	<1	<1	<1	<1	<1	<1
6 - 16	09/28/89	<100	15500	-	2170	884	<100	<100	19600	<100	711	<100	237	<100	<100	<100	<100	<100	<100	<100
(unconsolidated)																				
MW-12	08/30/89	14.7	3940	-	85.9	<10	<10	<10	540	12.8	<10	<10	14.8	<10	<10	<10	<10	<10	<10	<10
8 - 21	09/28/89	7.5	3150	-	69.5	53.1	15.6	<1	425	<1	12	<1	<1	<1	<1	<1	<1	<1	<1	<1
(unconsolidated)																				
MW-18	01/24/96	<25	1300	-	<25	<25	<25	<25	550	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
22 - 47																				
(rock)																				
MW-19	01/24/96	1400	510000	-	<50	3100 J	<50	<50	100000	780	<20000	<50	110	72	440	1100	<50	1800	1400	<50
300 - 422	02/13/96***	<20000	660000	<20000	<20000	<20000	<20000	<20000	220000	<20000	<20000	<20000	<20000	<20000	<20000	<20000	<20000	<20000	<20000	<20000
(rock)																				
MW-20	01/24/96	13	1800	-	<1	<1	<1	1.6	36	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	20
6.5 - 16.5																				
(unconsolidated)																				

Concentrations in ug/l (ppb)

1,1-DCA - 1,1 Dichloroethane
1,2-DCA - 1,2 Dichloroethane
1,1,2-TCA - 1,1,2 Trichloroethane
1,1,1-TCA - 1,1,1 Trichloroethane

1,4-DCB - 1,4 Dichlorobenzene
c-1,2-DCE - cis-1,2 Dichloroethene
t-1,2-DCE - trans-1,2 Dichloroethene
1,1-DCE - 1,1 Dichloroethene

TCE - Trichloroethene
PCE - Tetrachloroethene
CB - Chlorobenzene
CF - Chloroform

TCFM - Trichlorofluoromethane
DBCM - Dibromochloromethane
BDCM - Bromodichloromethane

(1) - Medium Specific Concentration for Used Aquifer
* - *nonresidential used aquifer where notated*
** - feet below grade
*** - Sampled collected after 29 hours of pumping during pump test; 1 hour/15 hour sample results not shown.
(-) - *Not analyzed*
J - Estimated concentration below method detection limit
Note: 1,1,1-TCA (1.4 ppb) and TCE (2.4 ppb) were detected in the trip blank submitted on 1/30/96.

July 29, 1996

Table 4
MW-17 and MW-19: Bottom Ground Water Samples
(January 1996 Sampling Event)
Bishop Tube Site
Frazer, Pennsylvania

Sample Location	MW-17 Bottom Sample	MW-19 Bottom Sample
Date Sampled	01/04/96	01/04/96
Parameter:	Concentration (ug/l)	
1,1,1-trichloroethane (TCA)	97000	57000
trichloroethene (TCE)	*350000*	*380000*
1,1-dichloroethene	9500	5600
1,1-dichloroethane	7300	8200

Note: For bottom samples, detection limits were 2500 - 5000 ug/l (Method 8240)

July 29, 1998

Table 5
VOC Results - MW-19 Pump Test Ground Water Samples
Bishop Tube Site
Frazer, Pennsylvania

Sample Location	MW-17	MW-17	MW-17
Hours after Start of Test	1	15	29
Date Sampled	02/13/96	02/13/96	02/14/96
Parameter:	Concentration (ug/l)		
1,1,1-trichloroethane (TCA)	430000	380000	220000
trichloroethene (TCE)	1200000	1000000	660000
1,1-dichloroethene	20000	<20000	<20000

Note: For pump test samples, detection limits were 20000 ug/l (Method 8010)
Pumped at 3.6 gpm for 30 hours with 215 ft drawdown
Samples collected through pump set at 330 ft below grade

July 29, 1998

TABLE 1
Well Information and Ground Water Levels
Bishop Tube Site
Frazer, Pennsylvania

Well ID	Depth to Well Bottom (ft.)	Depth to Top of Rock (ft.)	Depth of Screen Interval * (ft. below grade)	Ground Surface Elevation (ft. MSL)	Elevation of Screen Interval (ft. MSL)	Inner Casing Elevation ** (ft. MSL)	Depth to Water (top of inner casing) 07/07/98 (ft.)	Ground Water Elevation 07/07/98 (ft. MSL)
MW-1 *Rock*	48	—	28-48	423.86	395.86-375.86	424.21	13.98	410.23
MW-2 *Rock*	24	13	15-24	384.00	369.00-360.00	384.37	7.26	377.11
MW-3 *Unconsolidated*	13.5	13	8-13.5	383.94	375.94-370.44	384.66	6.64	378.02
MW-4 *Rock*	20	9	7-20	386.94	379.94-366.94	386.70	9.74	376.96
MW-5 *Unconsolidated*	20	—	10-20	387.44	377.44-367.44	387.16	11.53	375.63
MW-6 *Unconsolidated*	20.7	—	10.7-20.7	387.53	376.83-366.83	387.21	14.80	372.41
MW-7 *Unconsolidated*	19.8	—	9.8-19.8	396.96	387.16-377.16	398.69	9.19	389.50
MW-8 *Unconsolidated*	18	—	8-18	382***	374 - 364***	384.14	13.61	370.53
MW-9 *Rock*	63	26	46-63 (open bore hole)	382.81	336.81-319.81 (open bore hole)	384.10 (steel)	15.23	368.87
MW-10 *Rock*	15	4	5-15	384.96	379.96-369.96	383.87	na	na
MW-11 *Unconsolidated*	16	17	6-16	384.00	378.00-368.00	383.42	8.80	374.62
MW-12 *Unconsolidated*	21	20	8-21	383.15	375.15-362.15	382.46	8.32	374.14
MW-13 *Rock*	37	15	27-37	373.45	346.45-336.45	374.83	10.42	364.41
MW-14 *Unconsolidated*	15	15	5-15	373.18	368.18-358.18	374.30	9.68	364.62
MW-15 *Rock*	78	21	68-78	367.94	299.94-289.94	369.98	2.34	367.64
MW-16 *Unconsolidated*	21	17	7-21	367.91	360.91-346.91	369.80	7.77	362.03
MW-17 *Rock*	301	10	200-301 (open bore hole)	367.86	167.86-66.86 (open bore hole)	370.20 (steel)	5.87	364.33
MW-18 *Rock*	47	19	22-47	384.01	362.01-337.01	385.03	11.28	373.75
MW-19 *Rock*	412	15	300-422 (open bore hole)	384.47	84.47-(-37.53) (open bore hole)	384.24 (steel)	18.21	366.03
MW-20 *Unconsolidated*	16.5	17	6.5-16.5	387.96	381.46-371.46	387.96	4.92	383.04

na= not available (MW-10 was not located on 7/7/98)
(—) rock not encountered
(ft. MSL) = Elevation in feet above mean sea level
* PVC screen - open hole where noted
** PVC inner casing unless noted
*** - The ground and screen interval elevations for MW-8 are approximate until resurveying of the ground elevation is completed.

July 29, 1998

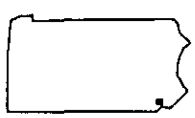
I:\PROJECTS\3552009\DWG\355215 1

FIGURE 1

(b) (6)

[redacted]

MAP ADAPTED FROM USGS 7.5 MINUTE QUAD TITLED MALVERN, PA.



STATE LOCATION MAP

BISHOP TUBE FACILITY
FRAZER, PENNSYLVANIA

SITE LOCATION MAP

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

SCALE: 1:24000

FILE NO.3552.009-01
9/98

ENGINEERS INC.

PLOT DATE: 9/4/98

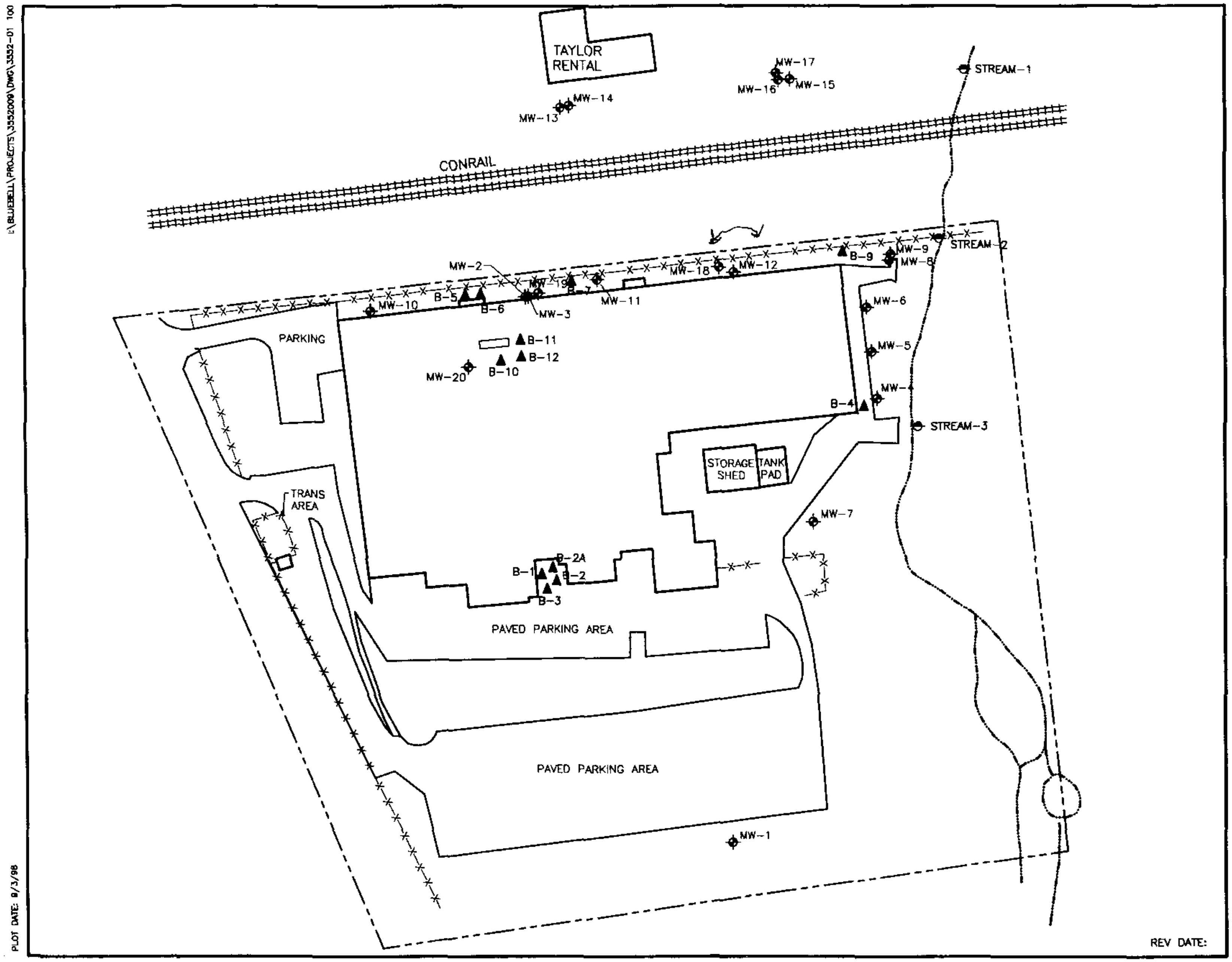


FIGURE 2

LEGEND

- GROUND WATER MONITORING WELL
- STREAM SAMPLING LOCATION
- SOIL BORING LOCATION
- STREAM
- FENCE LINE
- RAILROAD TRACKS

BISHOP TUBE FACILITY
FRAZER, PA

SITE PLAN

1"=100' 100 0 100

3552.009-02

O'BRIEN & GERE ENGINEERS INC.

Table 3
January 1996 Sampling Event - Summary of Analtyical Results
Groundwater and Stream Samples
Bishop Tube Site
Frazer, Pennsylvania

Sample Location	MW-4	MW-9	MW-13	MW-14	MW-15	MW-16	MW-16D	MW-17	MW-18	MW-19	MW-20	Domestic	Stream 1	Stream 2	Rinse Blank	Trip Blank	Trip Blank	Rinse Blank	Trip Blank	Trip Blank
Date Sampled	01/24/96	01/24/96	01/23/96	01/23/96	01/23/96	01/23/96	01/23/96	01/23/96	01/24/96	01/30/96	01/24/96	01/24/96	01/25/96	01/25/96	01/24/96	01/24/96	01/24/96	01/24/96	01/24/96	01/24/96
Parameter:										Concentration (ug/l)										
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	440	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,400	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,800	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	*72*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	780	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	110	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene (PCE)	23	ND	ND	ND	ND	ND	ND	ND	ND	1,400	13	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-dichloropropane	ND	170	ND	ND	380	110	90	13,000	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane (TCA)	13	290	1,400	310	4,800	920	930	50,000	550	100,000	36	8 1	19	ND	ND	ND	ND	ND	1.4	ND
trichloroethene (TCE)	490	2,300	2,900	1,200	1,400	650	660	110,000	1,300	510,000	1,800	53	75	10	ND	ND	ND	ND	2.4	ND
1,1-dichloroethene	ND	ND	ND	14	ND	ND	ND	ND	ND	3100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bromodichloromethane	ND	ND	ND	25	ND	ND	ND	ND	NA	NA	20	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND
										Concentration (mg/l)										
fluoride (unfiltered)	17.5	2.42	ND	ND	0.104	ND	ND	ND	0.102	0 126	ND	0 824	1.11	0.688	ND	NT	NT	ND	NT	NT
fluoride (filtered)	17.5	2.43	ND	ND	0.13	0.106	ND	0.101	ND	0.133	ND	0.835	1.08	0.629	ND	NT	NT	ND	NT	NT
chromium (unfiltered)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NA	NT	NT	0.01	0.009	NT	NT	NT	NT	NT	NT
chromium (filtered)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NA	NT	NT	0.008	0.008	NT	NT	NT	NT	NT	NT

ND - Not Detected
NT - Not Tested
NA - Data not available
Source - Smith Environmental Technologies Corporation (Smith Environmental Project No. 00-6471-03)

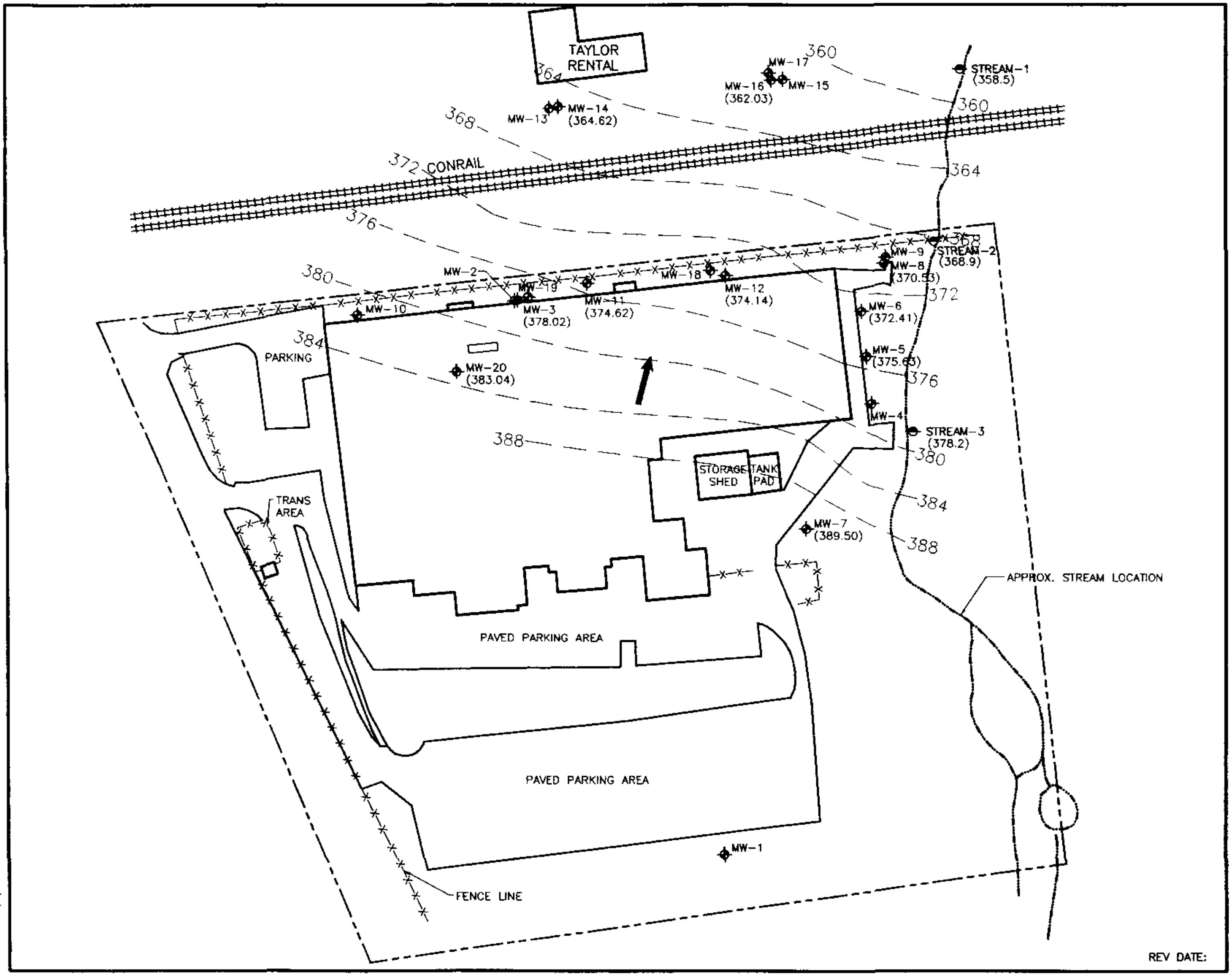


FIGURE 3

LEGEND

MW-9 (368.87) GROUND WATER MONITORING WELL WITH WELL DESIGNATION AND GROUND WATER ELEVATION (FT-MSL) MEASURED ON 7/7/98

APPROX. STREAM SAMPLING LOCATION

—364— GROUND WATER POTENTIOMETRIC CONTOUR (FT-MSL) BASED ON 7/7/98 DATA

INTERPRETED GROUND WATER FLOW DIRECTION

**BISHOP TUBE FACILITY
FRAZER, PA**

**OVERBURDEN GROUND WATER ELEVATION CONTOUR MAP
7/7/98**

1"=100' 100 0 100

3552.009-03

O'BRIEN & GERE ENGINEERS INC.

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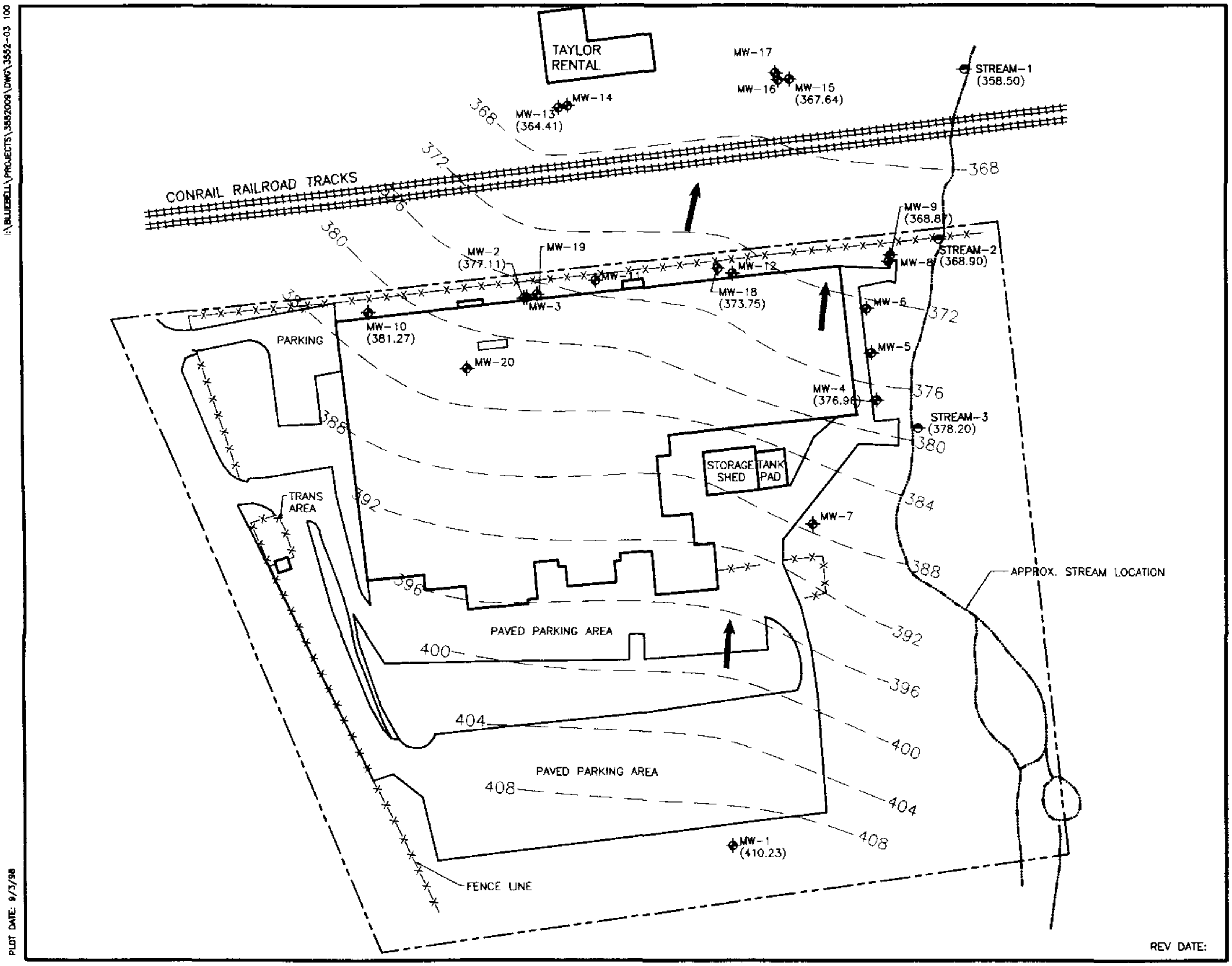
PLOT DATE: 9/3/98

FIGURE 4



LEGEND

MW-9 (368.87) GROUND WATER MONITORING WELL WITH WELL DESIGNATION AND GROUND WATER ELEVATION (FT-MSL) MEASURED ON 7/7/98

APPROX. STREAM SAMPLING LOCATION

—364— GROUND WATER POTENTIOMETRIC CONTOUR (FT-MSL) BASED ON 7/7/98 DATA

INTERPRETED GROUND WATER FLOW DIRECTION

BISHOP TUBE FACILITY
FRAZER, PA

UPPER BEDROCK GROUND WATER CONTOUR ELEVATION MAP
7/7/98

1"=100' 100 0 100

3552.009-04

O'BRIEN & GERE ENGINEERS INC.

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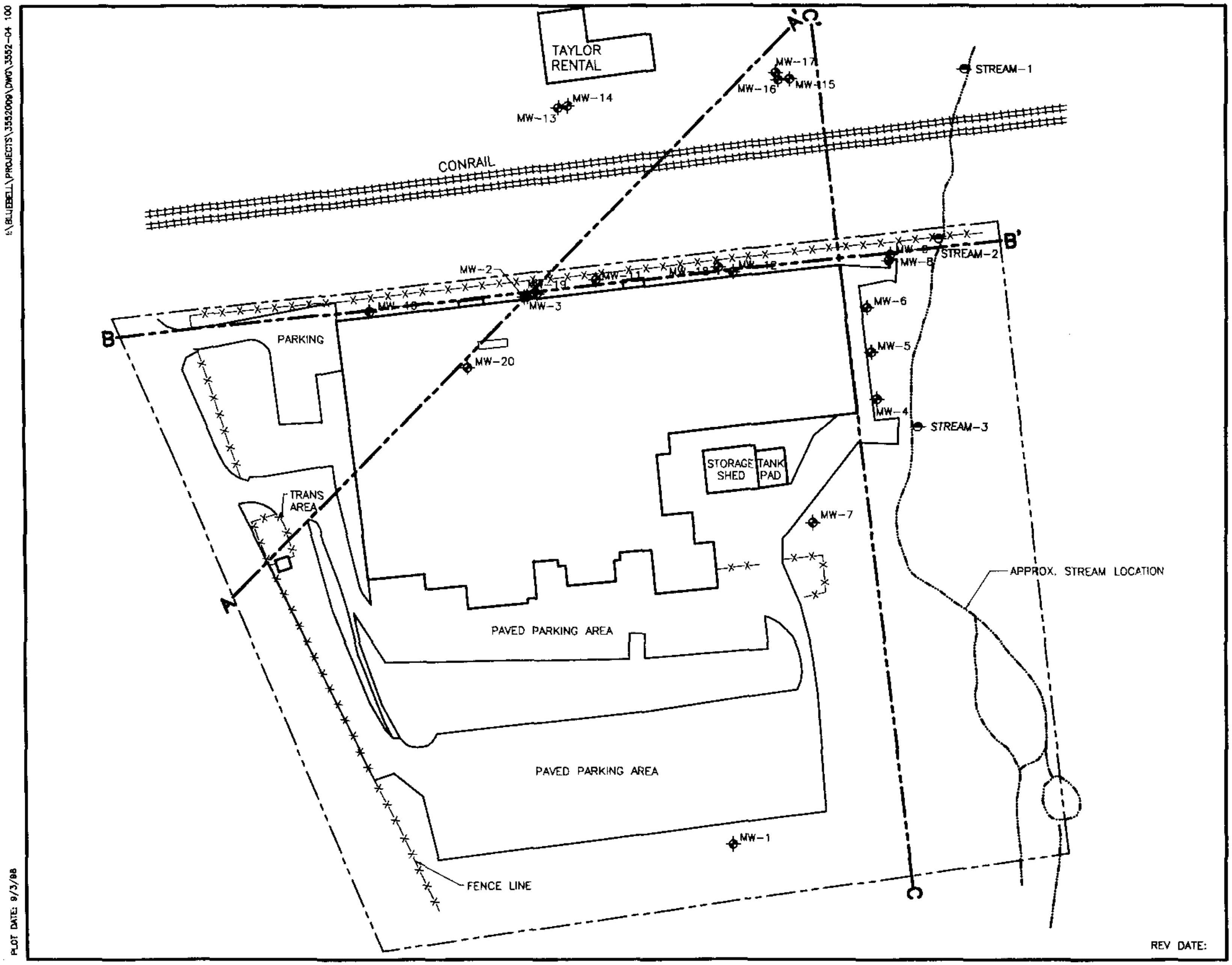

PLOT DATE: 9/3/98

FIGURE 5

LEGEND

MW-9 GROUND WATER MONITORING WELL WITH WELL DESIGNATION

APPROX. STREAM SAMPLING LOCATION

A A' LINE OF SECTION

NOTE:
SEE FIGURES 6, 7 AND 8 FOR SECTIONS A-A', B-B' AND C-C'.

BISHOP TUBE FACILITY
FRAZER, PA

LINE OF SECTION PLAN

1"=100' 100 0 100

3552.009-05

O'BRIEN & GERE ENGINEERS INC.

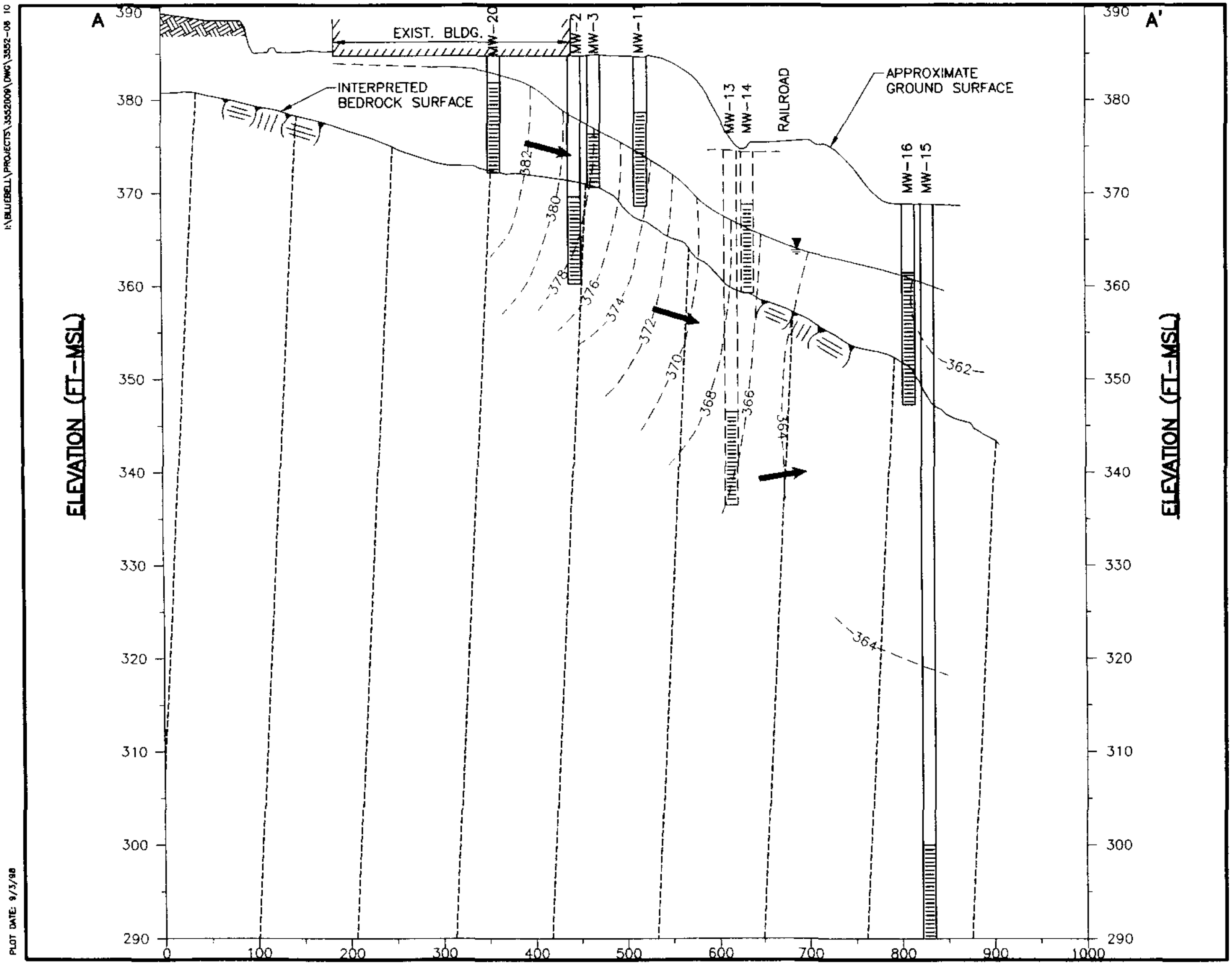

FIGURE 6

LEGEND

EXISTING MONITORING WELL

SCREENED PORTION OF WELL

EXISTING MONITORING WELL WITH APPROXIMATE GROUND SURFACE PROJECTED INTO INTO CROSS-SECTION

APPROXIMATE APPARENT DIP OF BEDROCK BEDDING PLANES

POTENTIOMETRIC SURFACE

-370- GROUND WATER POTENTIOMETRIC CONTOUR (FT-MSL), BASED ON 7/7/98 DATA

INTERPRETED GROUND WATER FLOW DIRECTION

BISHOP TUBE FACILITY
FRAZER, PA

GROUND WATER ELEVATION CONTOURS: SECTION A-A'
7/7/98

VERTICAL
1"=10' 10 0 10

HORIZONTAL
1"=100' 100 0 100

3552.009-06

O'BRIEN & GERE ENGINEERS INC.

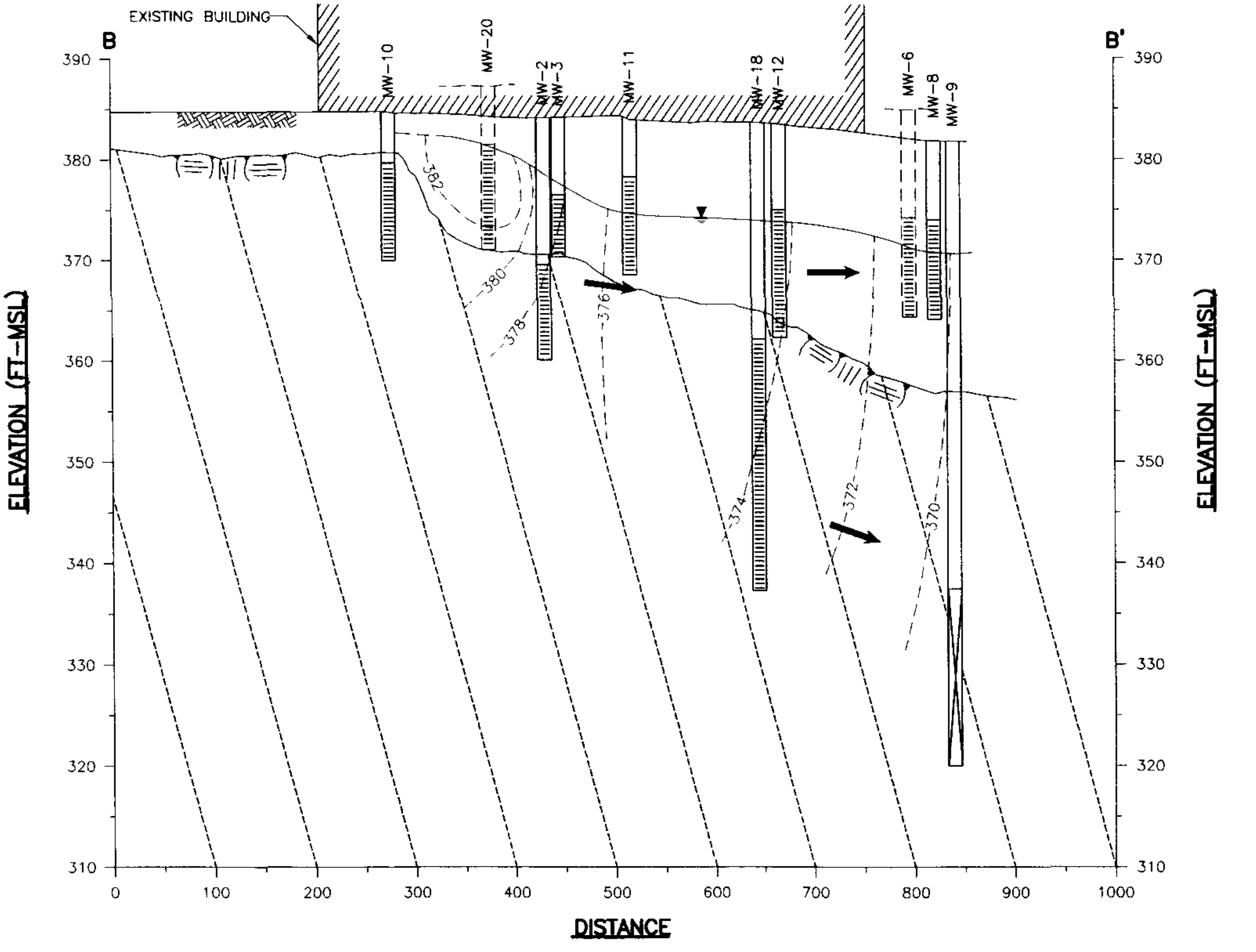

FIGURE 7

LEGEND

EXISTING MONITORING WELL

SCREENED PORTION OF WELL

EXISTING MONITORING WELL WITH APPROXIMATE GROUND SURFACE PROJECTED INTO INTO CROSS-SECTION

OPEN HOLE

APPROXIMATE APPARENT DIP OF BEDROCK BEDDING PLANES

POTENTIOMETRIC SURFACE

-370- GROUND WATER POTENTIOMETRIC CONTOUR (FT-MSL), BASED ON 7/7/98 DATA

INTERPRETED GROUND WATER FLOW DIRECTION

BISHOP TUBE FACILITY FRAZER, PA

GROUND WATER ELEVATION CONTOURS: SECTION B-B' 7/7/98

VERTICAL 1"=10' 10 0 10

HORIZONTAL 1"=100' 100 0 100

3552.009-07

O'BRIEN & GERE ENGINEERS INC.

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PLOT DATE: 8/3/98

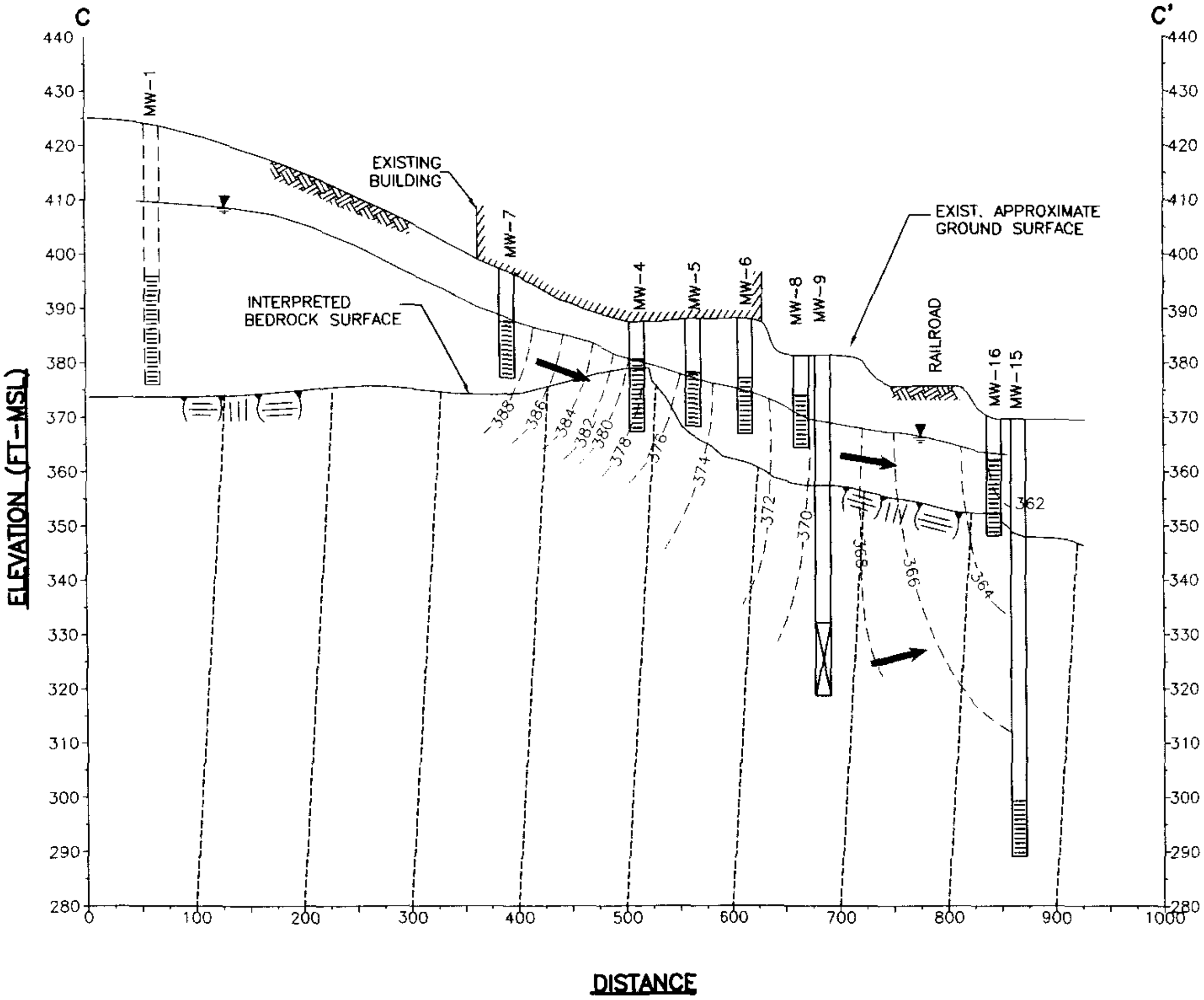

FIGURE 8

LEGEND

- EXISTING MONITORING WELL
- SCREENED PORTION OF WELL
- EXISTING MONITORING WELL WITH APPROXIMATE GROUND SURFACE PROJECTED INTO INTO CROSS-SECTION
- OPEN HOLE
- APPROXIMATE APPARENT DIP OF BEDROCK BEDDING PLANES
- POTENTIOMETRIC SURFACE
- -370- GROUND WATER POTENTIOMETRIC CONTOUR (FT-MSL), BASED ON 7/7/98 DATA
- INTERPRETED GROUND WATER FLOW DIRECTION

BISHOP TUBE FACILITY
FRAZER, PA

GROUND WATER ELEVATION CONTOURS: SECTION C-C'
7/7/98

VERTICAL
1"=20' 20 0 20

HORIZONTAL
1"=100' 100 0 100

3552.009-08

O'BRIEN & GERE ENGINEERS INC.

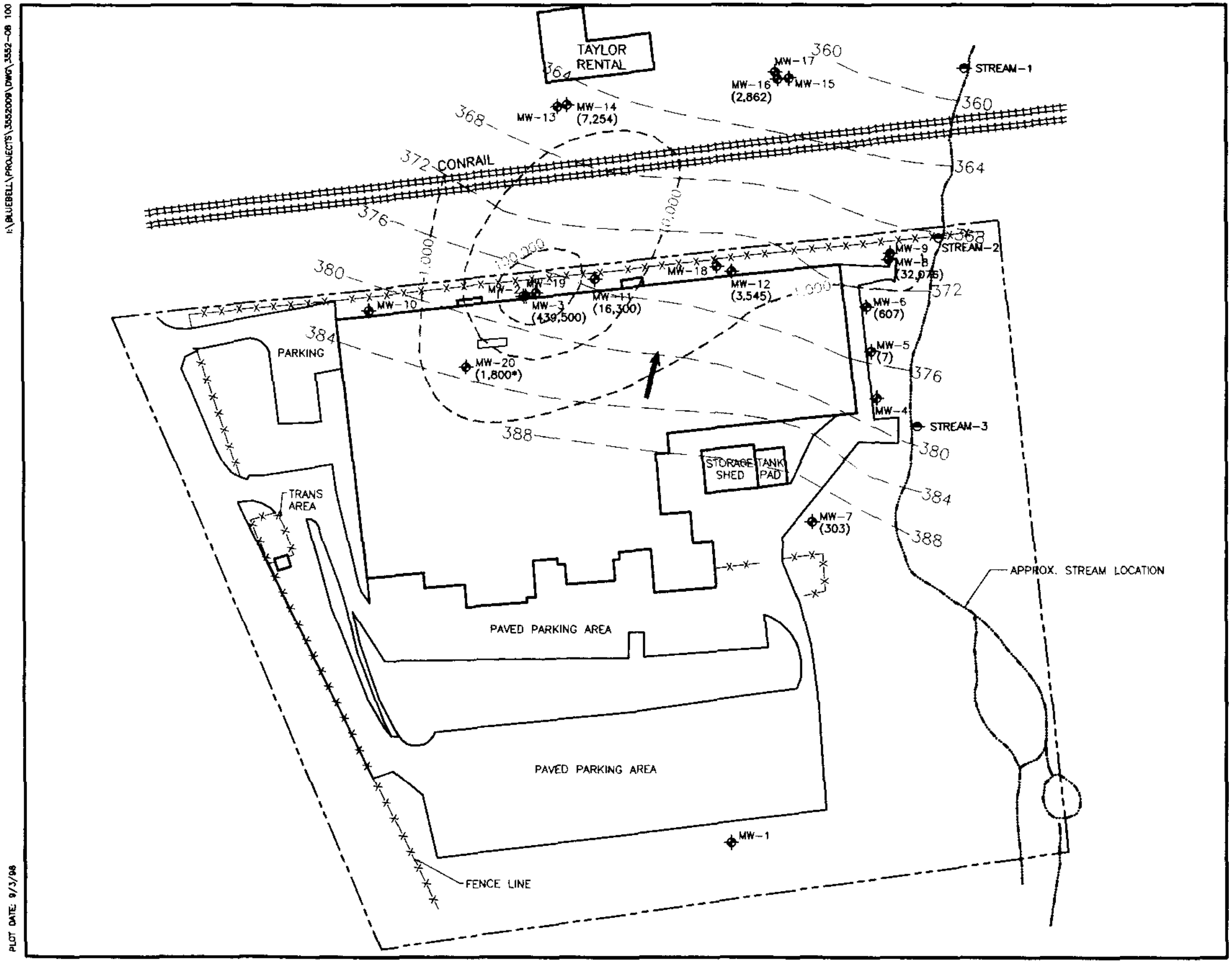

FIGURE 9

LEGEND

MW-9 (2,862) GROUND WATER MONITORING WELL WITH WELL DESIGNATION AND AVERAGE GROUND WATER TRICHLOROETHENE (TCE) CONCENTRATION IN PPB 1989 TO 1990 DATA (*DENOTES 1996 DATA)

APPROX. STREAM SAMPLING LOCATION

—1,000— TCE ISOCONCENTRATION CONTOUR IN PPB

BISHOP TUBE FACILITY FRAZER, PA

OVERBURDEN TRICHLOROETHENE ISOCONCENTRATION CONTOUR MAP

1"=100' 100 0 100

3552.009-09

O'BRIEN & GERE ENGINEERS INC.

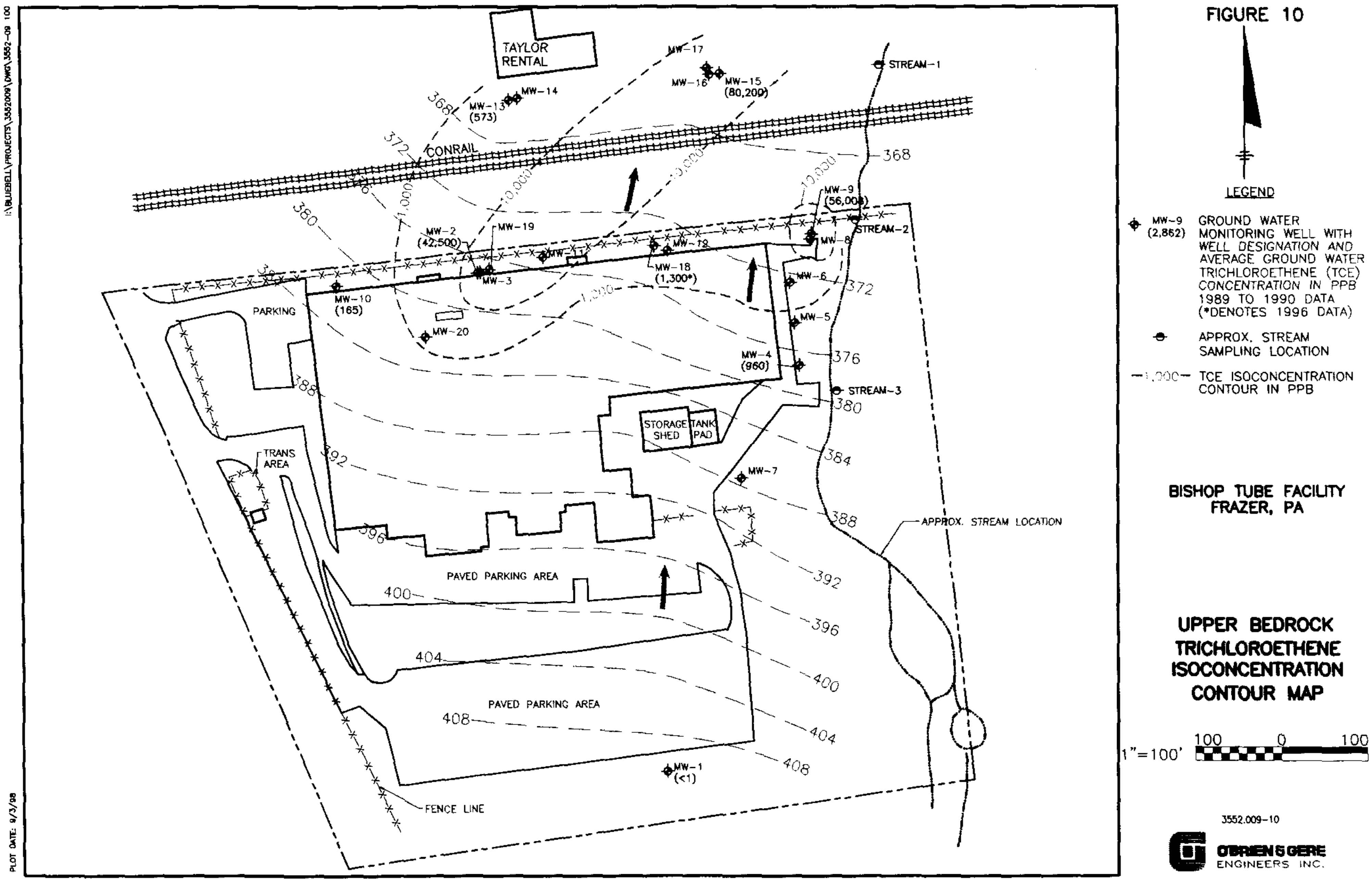
FIGURE 10
LEGEND
MW-9 (2,862) GROUND WATER MONITORING WELL WITH WELL DESIGNATION AND AVERAGE GROUND WATER TRICHLOROETHENE (TCE) CONCENTRATION IN PPB 1989 TO 1990 DATA (*DENOTES 1996 DATA)
APPROX. STREAM SAMPLING LOCATION
1,000 TCE ISOCONCENTRATION CONTOUR IN PPB
BISHOP TUBE FACILITY
FRAZER, PA
UPPER BEDROCK TRICHLOROETHENE ISOCONCENTRATION CONTOUR MAP
1"=100'
100 0 100
3552.009-10
O'BRIEN & GERE ENGINEERS INC.
TAYLOR RENTAL
CONRAIL
MW-17
MW-16
MW-15 (80,200)
MW-13 (573)
MW-14
STREAM-1
STREAM-2
STREAM-3
MW-9 (56,000)
MW-8
MW-2 (42,500)
MW-19
MW-3
MW-11
MW-12
MW-18 (1,300*)
MW-10 (165)
MW-20
MW-6
MW-5
MW-4 (960)
MW-7
MW-1 (<1)
PARKING
TRANS AREA
STORAGE SHED
TANK PAD
PAVED PARKING AREA
PAVED PARKING AREA
FENCE LINE
APPROX. STREAM LOCATION
10,000
1,000
368
372
376
380
384
388
392
396
400
404
408
I:\BLUEBELL\PROJECTS\3552009\DWG\3552-09 100
PLOT DATE: 9/3/98

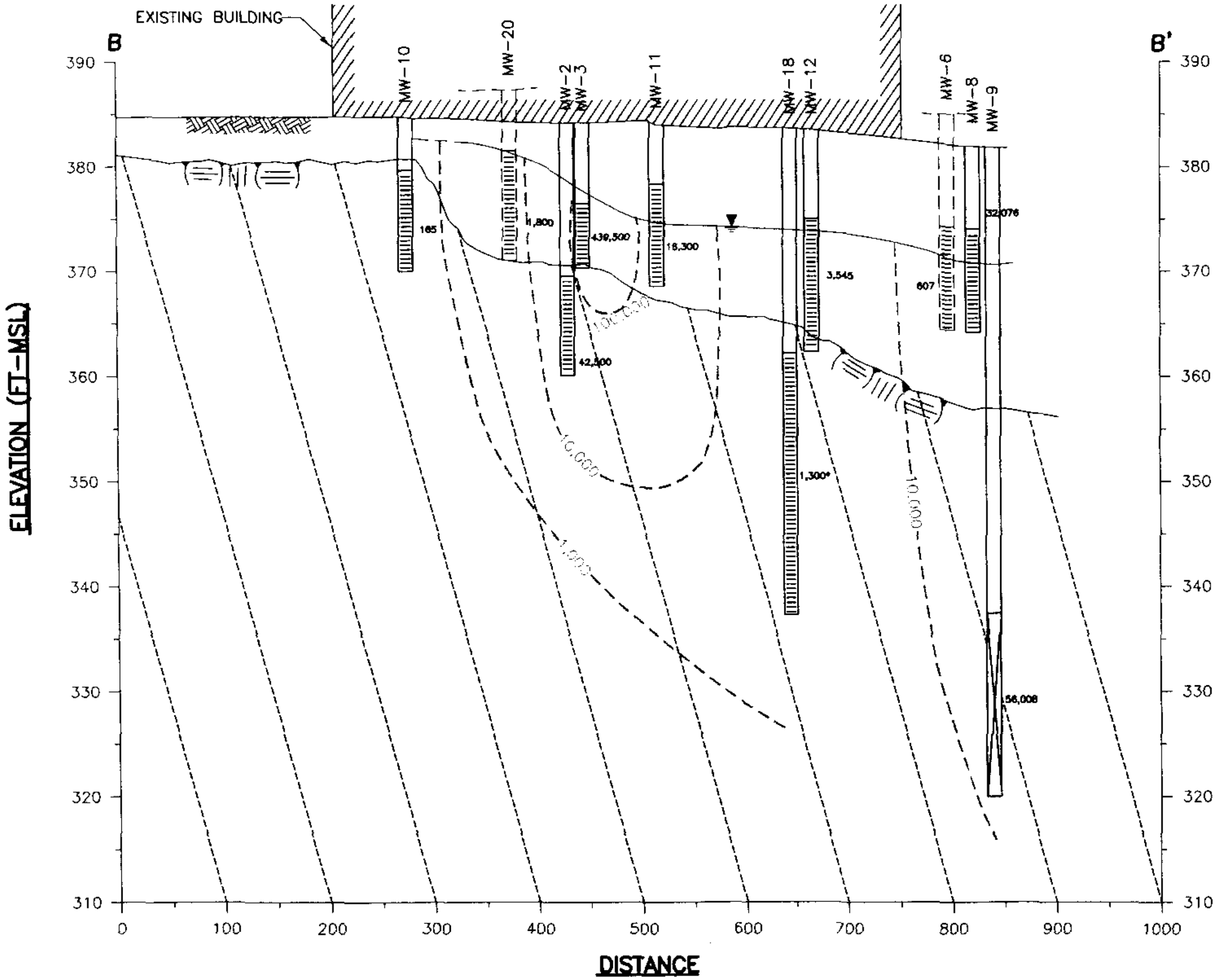

FIGURE 12

LEGEND

- EXISTING MONITORING WELL
- SCREENED PORTION OF WELL
- EXISTING MONITORING WELL WITH APPROXIMATE GROUND SURFACE PROJECTED INTO INTO CROSS-SECTION
- APPROXIMATE APPARENT DIP OF BEDROCK BEDDING PLANES
- POTENTIOMETRIC SURFACE
- 439,500 AVERAGE GROUND WATER TRICHLOROETHENE (TCE) CONCENTRATION IN PPB 1989 TO 1990 DATA (*DENOTES 1996 CONCENTRATION)
- 10,000 TCE ISOCONCENTRATION CONTOUR

BISHOP TUBE FACILITY
FRAZER, PA

TCE ISOCONCENTRATION CONTOURS: SECTION B-B'

VERTICAL 1"=10'

HORIZONTAL 1"=100'

3552.009-12

O'BRIEN & GERE ENGINEERS INC.

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PLOT DATE: 9/3/98

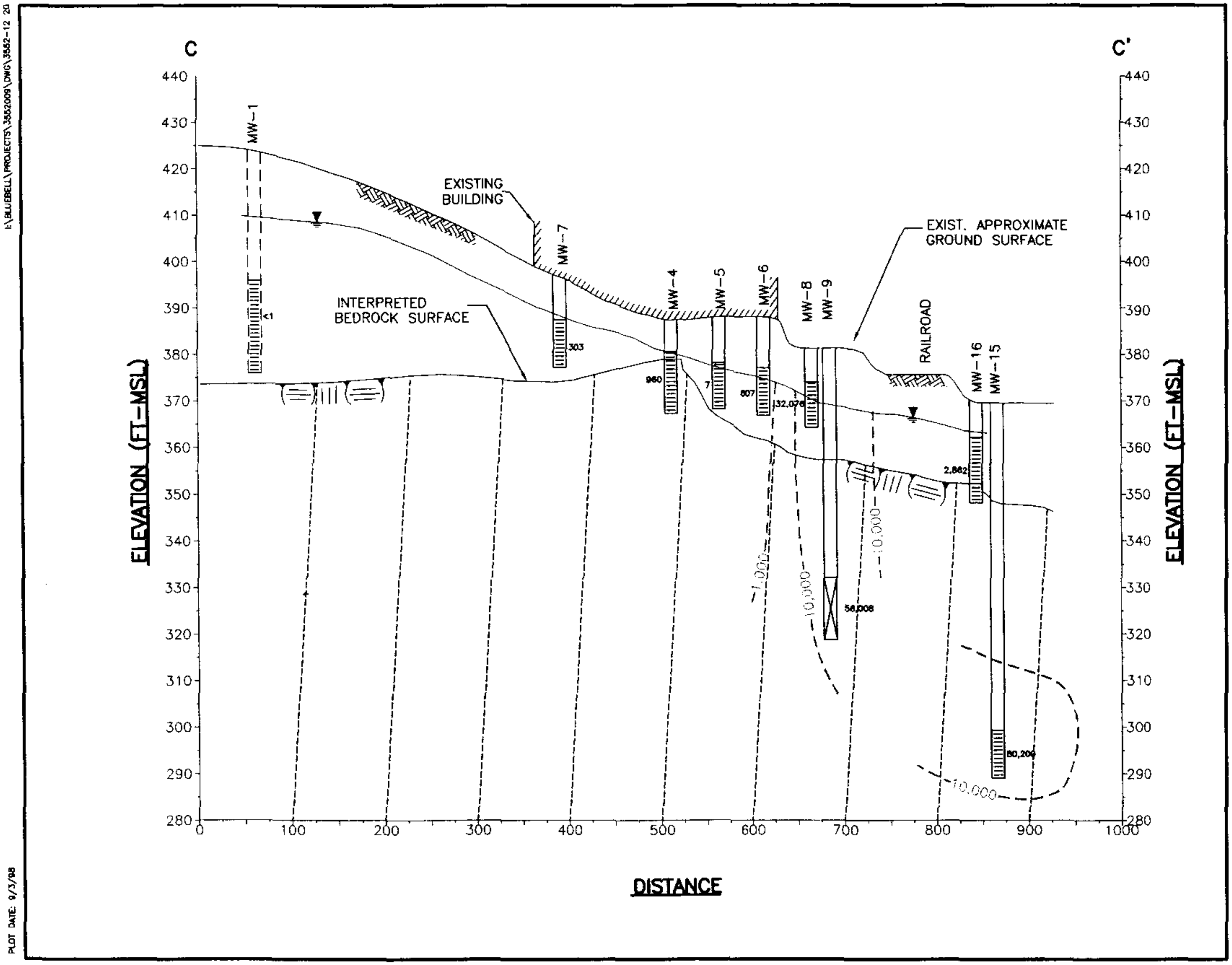


FIGURE 13

LEGEND

EXISTING MONITORING WELL

SCREENED PORTION OF WELL

EXISTING MONITORING WELL WITH APPROXIMATE GROUND SURFACE PROJECTED INTO INTO CROSS-SECTION

APPROXIMATE APPARENT DIP OF BEDROCK BEDDING PLANES

POTENTIOMETRIC SURFACE

439,500 AVERAGE GROUND WATER *TRICHLOROETHENE (TCE)* CONCENTRATION IN PPB 1989 TO 1990 DATA

10,000 TCE ISOCONCENTRATION CONTOUR

BISHOP TUBE FACILITY FRAZER, PA

TCE ISOCONCENTRATION CONTOURS: SECTION C-C'

VERTICAL 1"=20' 20 0 20

HORIZONTAL 1"=100' 100 0 100

3552.009-13

O'BRIEN & GERE ENGINEERS INC.

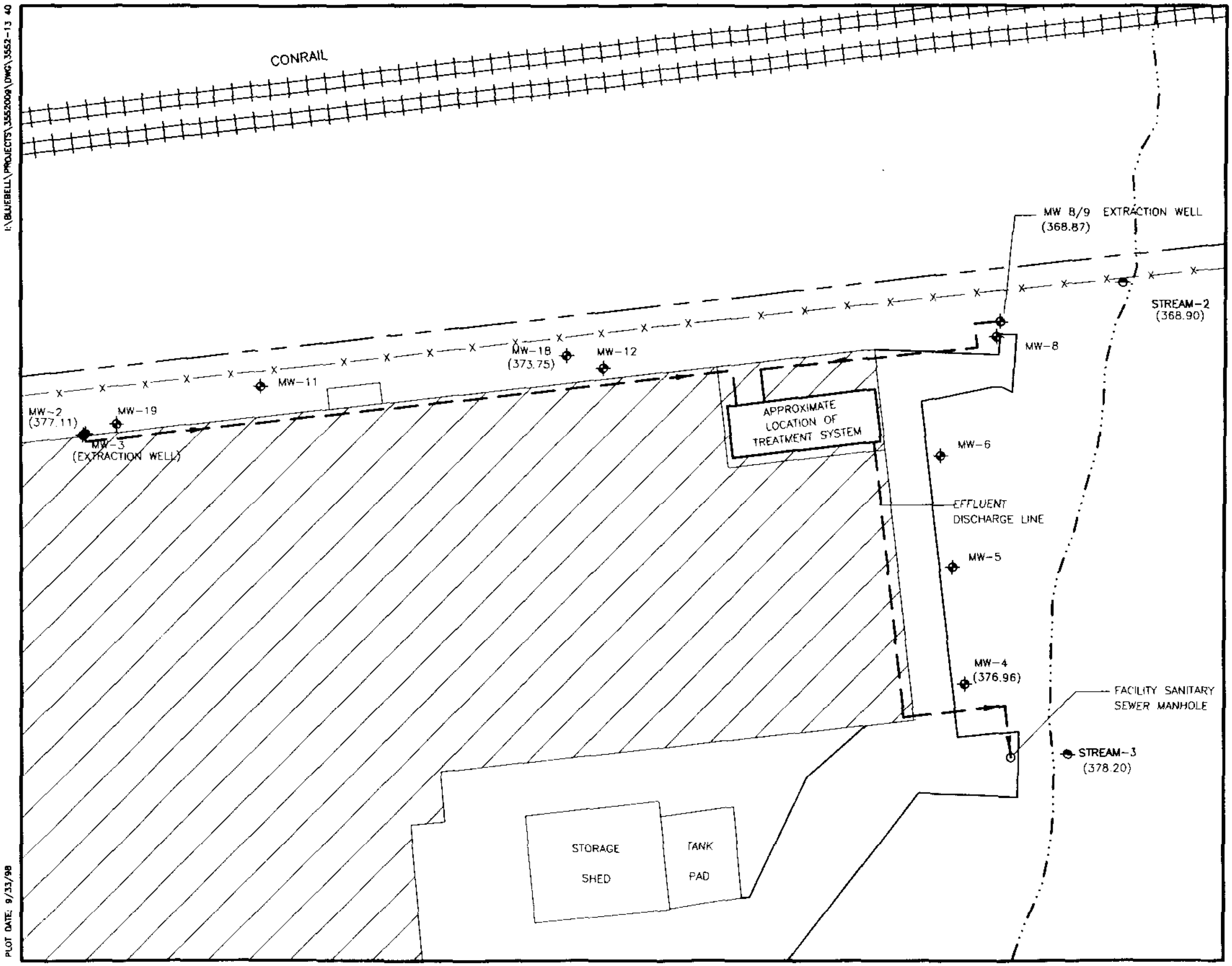


FIGURE 14

LEGEND

- GROUND WATER MONITORING WELL
- STREAM SAMPLING LOCATION

BISHOP TUBE FACILITY
FRAZER, PA

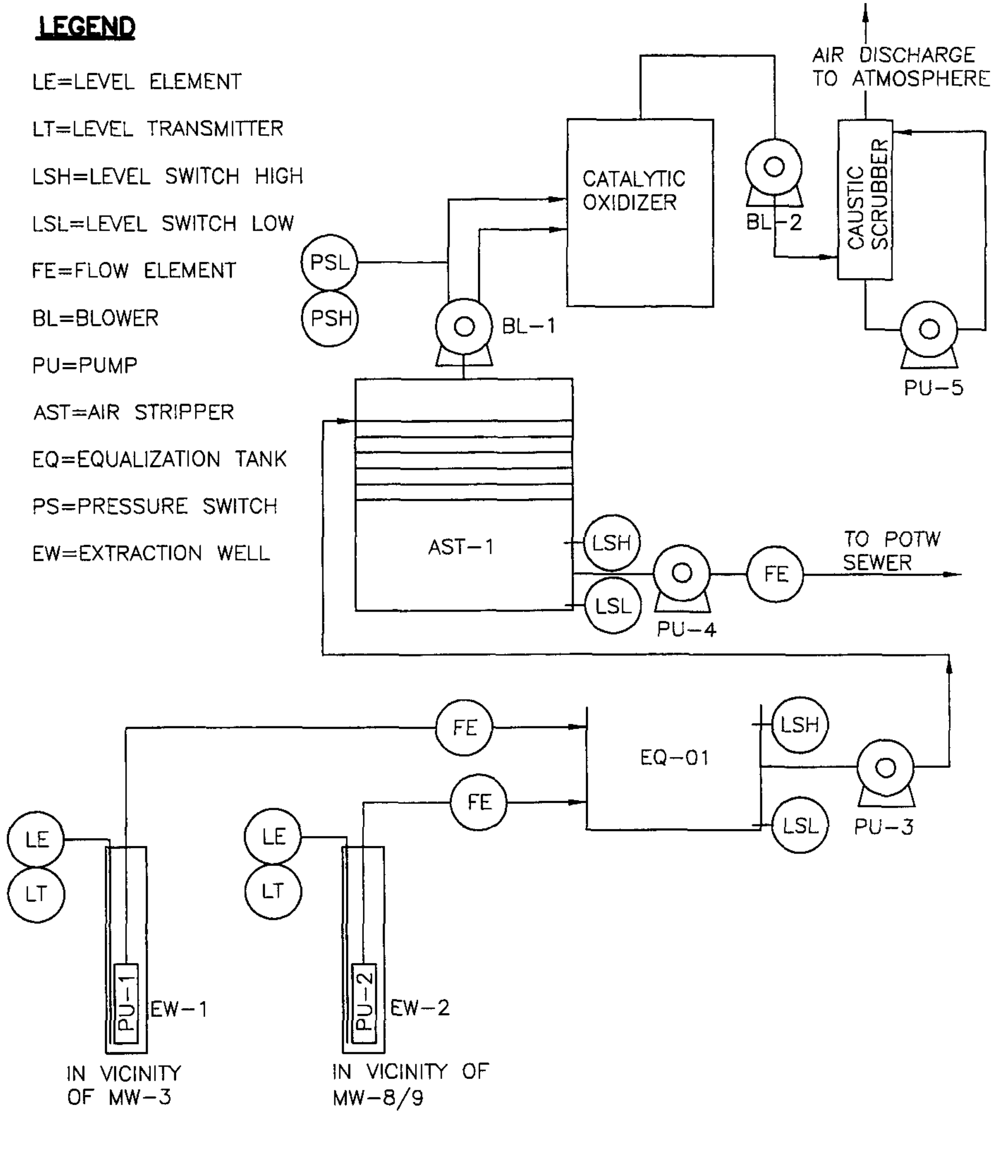
APPROXIMATE LOCATION OF TREATMENT SYSTEM

1"=40' 40 0 40

3552.009-14

O'BRIEN & GERE ENGINEERS INC.

FIGURE 15



BISHOP TUBE FACILITY
FRAZER, PA
CONCEPTUAL PROCESS FLOW DIAGRAM
(WITH CATALYTIC OXIDIZER OFF GAS TREATMENT)

3552.009-15
DATE: 9/3/98

NOT TO SCALE

ENGINEERS INC.

INTERIM REMEDIAL ACTION PLAN
IMPLEMENTATION SCHEDULE
BISHOP TUBE SITE

FIGURE 16